
**LOCAL PROTECTION PROJECT
WEST RIVER
NEW HAVEN, CONNECTICUT**

Operation and Maintenance Manual

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**US Army Corps
of Engineers**
New England Division

OPERATION AND MAINTENANCE MANUAL

FOR

LOCAL FLOOD PROTECTION WORKS

ON

WEST RIVER

AT

NEW HAVEN, CONNECTICUT

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254-9149

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OPERATION AND MAINTENANCE MANUAL
FOR
FLOOD PROTECTION SYSTEM
NEW HAVEN, CONNECTICUT

FOREWORD

In order to assure the successful functioning of the flood protection system, the entire system must be properly maintained and operated.

The need for proper maintenance cannot be too highly stressed in view of the fact that damages may be incurred through operating failure of a critical element in time of need, caused by deterioration or damage that would have been eliminated by proper maintenance.

Necessary maintenance and proper operation require that responsible persons have a thorough understanding of the functions of the various units of the project and the recommended methods of maintaining the system and operating it during flood emergencies. It is the purpose of this manual to provide complete information so that all parties may fully understand their responsibilities in maintaining and operating the flood protection system in accordance with the regulations prescribed by the Secretary of The Army as amplified by this manual.

The general Flood Control Regulations for Maintenance and Operation of Flood Control Works quoted herein were approved by the Acting Secretary of War on 9 August 1944. Upon establishment of the Department of Defense, the improvement of rivers and harbors and other waterways for flood control and other purposes, formerly under the jurisdiction of the Secretary of War, became the responsibility of the Secretary of The Army. Reference therein to the Secretary of War and War Department shall be construed to mean, respectively, the Secretary of The Army and the Department of The Army. Where reference is made to the Division Engineer in the regulations included in this manual, it shall be construed to mean the Division Engineer, New England Division, Corps of Engineers.

OPERATION AND MAINTENANCE MANUAL

LOCAL FLOOD PROTECTION WORKS

NEW HAVEN, CONNECTICUT

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OPERATION AND MAINTENANCE MANUAL
LOCAL FLOOD PROTECTION WORKS
NEW HAVEN, CONNECTICUT

SECTION I. INTRODUCTION

1-01 AUTHORIZATION

The flood protection project on the West River in the city of New Haven, Connecticut, was authorized for construction by the Assistant Secretary of the Army on 26 September 1988 pursuant to the Continuing Authorities Program provided by the provisions of Section 205 of the Flood Control Act of 1948.

1-02 LOCATION

The project is located in New Haven, Connecticut, along the West River and Wintergreen Brook. The portion of the project along the West River starts at Park Dike on the north side of Blake Street, and extends to Whalley Avenue. The portion of the project along Wintergreen Brook starts at Blake Street and extends to where Wintergreen Brook empties into the West River.

1-03 DATES OF CONSTRUCTION

The flood control project along the West River and Wintergreen Brook in New Haven, Connecticut, was constructed by Trevcon Incorporated of Gilford, Connecticut. Notice to proceed was issued on 30 October 1990, and construction was essentially completed during February 1993.

1-04 DESCRIPTION OF PROJECT

a. General. The completed flood protection project consists primarily of improvements along the West River and Wintergreen Brook between Blake Street and Whalley Avenue. Improvements include widening channels, new precast concrete modular walls, new concrete I-walls, a new cantilever wall, new earth dikes, and improvements to parking lots and driveways. The project also includes interior drainage provisions at the New Haven Manufacturing Company.

b. Channel Improvements. Channel improvements were made to the West River and Wintergreen Brook between Blake Street and Whalley Avenue to widen channels to increase flow capacity.

c. Earth Dike. The dike along Wintergreen Brook consists of compacted random fill covered with a 12-inch layer of gravel bedding and an 18-inch layer of stone protection.

d. Park Dike. The Park Dike, which runs along the north side of Blake Street, consists of compacted random fill covered with a 12-inch layer of gravel bedding and a 4-inch mat of interlocking precast concrete blocks.

e. Precast Concrete Modular Wall. The west bank of the West River from Blake Street to Whalley Avenue is protected by a precast modular wall system that ranges from EL. 17.50 ft, NGVD to EL. 16.50 ft, NGVD.

f. I-Walls. New Haven Manufacturing Company is protected by a concrete I-wall starting at Blake Street, extend along the left bank of the West River, to the confluence with Wintergreen Brook. The I-wall then continues up the right bank of Wintergreen Brook, and terminates at the dike along Wintergreen Brook.

g. Cantilever Wall. A cantilever wall to EL. 17.00 ft, NGVD on the west bank of Wintergreen Brook provides protection between Blake Street and the earth dike.

h. Interior Drainage Provisions. Storm water collected from New Haven Manufacturing passes through a gated drainage structure, and is discharged into the West River. During periods of high river flow, the drainage structure is gated closed, and diesel engine driven portable pumps are used to pump storm water over the floodwalls.

i. Portable Pumps. The flood control project is provided with three diesel engine driven portable pumps. The pumps are used to pump storm drainage from the drainage structure behind the New Haven Manufacturing Company.

1-05 PROTECTION PROVIDED

The flood protection system primarily protects commercial and industrial areas along the West River and Wintergreen Brook between Blake Street and Whalley Avenue in New Haven. The New Haven Manufacturing Company is the primary beneficiary of the protection works.

1-06 LOCATION MAP

Refer to Appendix F, Plate 1 for location map showing relative location of all major flood protection facilities.

SECTION II. LOCAL COOPERATION REQUIREMENTS

2-01 FLOOD CONTROL ACTS

The pertinent requirements of local cooperation as contained in Public Law 94-587 read as follows:

"(b) Prior to initiation of construction of the project, appropriate non-Federal interests shall agree-

(1) to provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction and operation of the project,

(2) to hold and save the United States free from damages due to the construction, operation and maintenance of the project not including damages due to the fault or negligence of the United States or its contractor,

(3) to accomplish without cost to the United States all modifications or relocations of existing sewerage and drainage facilities, buildings, utilities, and highways made necessary by construction of the project not to include sewerage and drainage facilities at the line of protection,

(4) to maintain and operate all features of the project after completion in accordance with regulations prescribed by the Secretary of The Army, and

(5) to bear 25 per centum of the total first cost.

(c) Notwithstanding subsection (b) of this section or any other provision of law, non-Federal interests shall bear no part of the cost of any design for this project rejected or otherwise not accepted by such interests prior to the date of enactment of this section."

2-02 LOCAL ASSURANCES

A copy of local assurances is given in Appendix D of this manual.

SECTION III. GENERAL REGULATIONS

3-01 PURPOSE OF THIS MANUAL

The purpose of this manual is to present detailed information to be used as a guide in complying with "Flood Control Regulations - Maintenance and Operation of Flood Control Works" as approved by the Acting Secretary of War on 9 August 1944, and published in the Federal Register on 17 August 1944, a copy of which is bound in the back of this volume as Appendix A. The regulations are intended to cover all local projects constructed by the Department throughout the United States. However, they are general in nature and cannot give detailed instructions for the maintenance and operation of a specific project. The details set forth in this manual for maintenance and operation of the West River Local Protection Project are intended to supplement these regulations. Failure to maintain and operate the project as required by the regulations and as detailed herein may cause severe property losses and loss of life, and may result in an irreparable loss of confidence in the flood protection system among citizens whose funds have been invested in it.

3-02 GENERAL RULES AND REGULATIONS

The general rules of the regulations prescribed by the Secretary of War to govern the maintenance and operation of flood control works are given in quotation marks in the following paragraphs and are defined further by remarks under each quotation.

"(1) The structures and facilities constructed by the United States for local protection shall be continuously maintained in such a manner and operated at such times and for such periods as may be necessary to obtain the maximum benefits."

These requirements cannot be overstressed. The authorities must have adequate provisions for funds, personnel, equipment, and materials to allow for the proper maintenance and operation of the protection works and associated facilities.

"(2) The State, political subdivision thereof, or other responsible local agency, which furnished assurance that it will maintain and operate flood control works in accordance with regulations prescribed by the Secretary of War, as required by law, shall appoint a permanent committee consisting of or headed by an official hereinafter called the Superintendent who shall be responsible for the development and maintenance of, and directly in charge of, an organization responsible for the efficient operation and maintenance of all structures and facilities during flood periods and for

continuous inspection and maintenance of the project works during periods of low water, all without cost to the United States."

The operating staff shall be composed of competent, responsible and adequately trained personnel. The name, address, and office and home telephone numbers of the individual heading the staff, and any changes thereof, shall be promptly furnished to the Division Engineer, U.S. Army Corps of Engineers, New England Division, Waltham, Massachusetts, 02254.

"(3) A reserve supply of materials needed during a flood emergency shall be kept on hand at all times."

Provision shall be made for replacement of critical component parts by maintaining a frequently updated inventory of on-site parts and tools accompanied by a list of manufacturers and suppliers from whom necessary items might be obtained quickly in the event of an emergency.

"(4) No encroachment or trespass which will adversely affect the efficient operation or maintenance of the project works shall be permitted upon the rights-of-way for the protective facilities."

Areas of public access and areas where the public is prohibited shall be clearly marked. The disposal of rubbish or floating debris on or near the project shall be prohibited.

"(5) No improvement shall be passed over, under or through the walls, levees, improved channels or floodways, nor shall any excavation or construction be permitted within the limits of the project right-of-way, nor shall any change be made in any feature of the works without prior determination by the Division Engineer of the War Department or his authorized representative that such improvement, excavation, or alteration will not adversely affect the functioning of the protective facilities. Such improvements or alterations as may be found to be desirable and permissible under the determination shall be constructed in accordance with standard engineering practice. Advice regarding the effect of proposed improvements or alterations on the functioning of the project and information concerning methods of construction acceptable under standard engineering practice shall be submitted for his approval. Drawings or prints showing such improvements or alterations as finally constructed shall be furnished to the Division Engineer after completion of the work."

Any contemplated improvements or alterations as outlined above must be submitted to the Division Engineer, U.S. Army Corps of Engineers, New England Division, and the approval of the

Division Engineer obtained prior to the city authorizing the work. All requests for approval shall be in writing. Complete drawings in duplicate, one set of which shall be in reproducible form must be submitted along with a full description of the work intended. The city will be held responsible for obtaining prior approval from the U.S. Army Corps of Engineers, New England Division, of any improvement or alterations proposed by themselves, private parties or any public utilities. The city shall furnish the Division Engineer with two complete sets of as-built drawings showing the completed work.

"(6) It shall be the duty of the Superintendent to submit a semi-annual report to the Division Engineer covering inspection, maintenance and operation of the protective works."

See Section III, paragraph 3-05, of this manual for instructions on submitting reports.

"(7) The Division Engineer or his authorized representatives shall have access at all times to all portions of the protective works."

The Division Engineer or his representatives will make periodic inspections of the protective works to determine if the project is being properly maintained and operated by the city. "Follow-up" inspections, when necessary, will be made to determine if deficiencies observed during the inspection have been corrected. A report with the results of each inspection will be furnished to the city for appropriate action.

"(8) Maintenance measures or repairs which the Division Engineer deems necessary shall be promptly taken or made."

The city should maintain the facilities and keep them in good repair and not wait for the Division Engineer to call matters to its attention. The Division Office will be available to advise the city how to make any major repairs to the facilities.

"(9) Appropriate measures shall be taken by local authorities to insure that the activities of all local organizations operating public or private facilities connected with the protective works are coordinated with those of the Superintendent's organization during the flood periods."

The city should formulate plans and negotiate agreements with local organizations and companies, who are operating facilities connected with the protection works, to insure that their activities will be properly coordinated with the Superintendent's organization during storm periods.

"(10) The War Department will furnish local interests with an Operation and Maintenance Manual for each completed project, or separate useful part thereof, to assist them in carrying out their obligations under these regulations."

The city operating staff should familiarize itself with the contents of this manual. The Superintendent should conduct classes to instruct his subordinates in proper maintenance and operation of the flood protection facilities as outlined in the manual. The city authorities are encouraged to call on the U.S. Army Corps of Engineers Division office for any additional advice or instructions required by them in carrying out their obligations for maintaining and operating the flood protection facilities.

3-03 MAINTENANCE

a. Definition. The word "maintenance" as used in this manual, applies to the upkeep, repair and care of the work constructed by the Department of Defense and turned over to the city. Failure to properly maintain the structures will lead to deterioration and possible failure during a flood when there is need of dependable protection. Satisfactory and dependable operation depends on constant maintenance. The organization which is responsible for maintenance will be familiar with all parts of the system and will be in a position to operate them effectively in time of stress.

b. Inspection. Maintenance involves regular inspection of the entire system to detect any deterioration or faulty operation that needs repair. This does not mean a casual look at areas easily accessible, but a thorough inspection of every part of the system.

c. Testing. In addition to inspection, the diesel engine driven portable pumps require testing at regular intervals to uncover any difficulties that might prevent the equipment from performing its function during an emergency. The applicable sections of this manual indicate recommended frequency of maintenance and operation of the pumps. It is recommended that a chart be kept for the purpose of recording completed operation and maintenance checks and the dates accomplished.

3-04 OPERATION

a. Definition. The word "operation" as used in this manual refers to the actual use of the various features of the protection works when the city is threatened by possible high waters.

b. Operating Authority. When danger from high waters is expected, it is important that decisions be made and prompt action taken. The responsible person in charge for the city of New Haven must have the authority to carry out his decisions. To insure correct operation, it is essential that at least one person (preferably two people) is familiar with all phases of the protection works. This person or persons must: know when to start the portable pumps, know the location of gates and valves and when to close them, know what supplies are on hand and how they are to be transported to danger points, and know what persons and tools can be mobilized for patrolling and repair works.

c. Agreements with Private Parties. It will be to the city's advantage to negotiate agreements with private owners and companies to operate and maintain project features that are directly related to facilities and property of parties. The city must remember, however, that the New England Division Corps of Engineers will look only to the city for maintenance and operation of the project since that is the body which executed assurances of local cooperation.

d. Corps of Engineers Assistance. Representatives of the New England Division Corps of Engineers stand ready to advise the city in the operation of the project. Advice relative to regulation during storm periods may be obtained at any time from the Reservoir Control Center of the New England Division Corps of Engineers (See Plate B-1). However, sole responsibility for the operation of the project rests with the city.

3-05 REPORTS

a. When to Submit Reports. The regulations prescribed by the Secretary of War call for reports covering inspection, maintenance and operation to be submitted by the Superintendent to the Division Engineer, U.S. Army Corps of Engineers, New England Division, Waltham, Massachusetts, 02254. Inspection of the flood protective facilities shall be made immediately prior to flood seasons, immediately following floods, and otherwise at intervals not exceeding 90 days as required by the regulations. Floods can occur in any month of the year, however spring river flow is higher than other seasons of the year.

b. Report Forms. To assist the Superintendent in making his inspections, a series of report forms for the individual features has been prepared. Samples of these forms are given in Appendix C. The Superintendent will have additional copies printed for use in submitting his reports.

c. Semi-annual Reports. The semi-annual reports should be submitted in triplicate to the Division Engineer, U.S. Army Corps of Engineers, New England Division, Waltham, Massachusetts, 02254-9149, each February and August. The reports will be submitted in letter form with copies of the inspection forms covering the inspections made during the period of the report. The report shall cover the following points:

- (1) A description of the maintenance work performed in the preceding six months.
- (2) The number and classification of men working on maintenance, regularly and intermittently.
- (3) Description of any work performed by contract on the repair or improvement of the project.
- (4) Description of any use or operation of the system during the period being reported.

d. Designation of Superintendent. The report form "Designation of Superintendent" shall be submitted annually with the February inspection report.

SECTION IV. DIKES

4-01 DESCRIPTION

Two earth dikes were constructed as part of the flood protection system for the West River Local Protection Project.

a. Park Dike. Park Dike is on the north side of, and runs parallel to Blake Street. The dike is approximately 290 feet long and has a top elevation of 18.50 feet NGVD. The top of the dike is 10 feet wide. The dike is constructed of compacted random fill covered with 12-inches of gravel bedding, and 4-inch thick precast concrete blocks. Voids in the precast blocks were filled with topsoil and seeded.

b. Wintergreen Brook Dike. The dike is on the east bank of Wintergreen Brook and runs from the cantilever wall to the concrete I-wall. The dike is approximately 460 feet long and has a top elevation of 17.50 ft, NGVD. The top of the dike is 10 feet wide. The dike is constructed of compacted random fill covered with 12-inches of gravel bedding and 18-inches of stone protection.

4-02 MAINTENANCE

a. Regulations. The regulations prescribed by the Secretary of War under paragraph 208.10(b)(1) give rules for the maintenance of levees. These rules also apply to dikes and are quoted here to avoid cross references to the regulations. Following this, a few of the points that apply particularly to the city of New Haven will be discussed.

"Levees. - (1) Maintenance. - The Superintendent shall provide at all times such maintenance as may be required to insure serviceability of the structures in time of flood. Measures shall be taken to promote the growth of sod, exterminate burrowing animals, and provide for routine mowing of the grass and weeds, removal of wild growth and drift deposits, and repair of damage caused by erosion or other forces. Periodic inspections shall be made by the Superintendent to insure that the above maintenance measures are being effectively carried out and further, to be certain that:

(i) No unusual settlement, sloughing or material loss of grade of levee cross section has taken place;

(ii) No caving has occurred on either the landside or the riverside of the levee which might affect the stability of the levee section;

(iii) No seepage, saturated areas, or sand boils are occurring;

Such inspections shall be made immediately prior to the beginning of the flood season; immediately following each major high water period, and otherwise at intervals not exceeding 90 days; and such intermediate times as may be necessary to insure the best possible care of the levee. Immediate steps will be taken to correct dangerous conditions disclosed by such inspections. Regular maintenance repair measures shall be accomplished during the appropriate season as scheduled by the Superintendent."

b. Major Repairs. Any unusual settlement, sloughing or caving should be corrected to restore the original dike grades. No major repair work shall be made without prior approval of the Division Engineer, New England Division, in order that such repairs will not adversely affect the functioning of the protective facilities.

c. Repairs to Turf. The slopes of Park Dike were topsoiled and seeded to minimize the damage from erosion and scour caused by surface runoff. Maintenance of a sturdy sod growth on these embankments is very important as sod is one of the most effective means of protecting the levee against erosion. Periodic mowing is essential to maintain a good sod growth, and should be done at such intervals as necessary to keep down weeds and other noxious growth. Grass height should never exceed 12-inches.

d. Reestablishing Turf. When sections of Park Dike require reestablishment of turf, seeding operations should be started at the earliest practicable date in the spring to secure the greatest possible protection against erosion. Areas requiring seeding shall be dressed to fill gullies and irregularities in the surface. The following seed mixture is recommended:

TABLE 1

GRASS SEED

<u>KIND OF SEED</u>	<u>% BY WEIGHT PROPORTION</u>	<u>GERMINATION MINIMUM %</u>	<u>PURITY MINIMUM %</u>
Red Fescue	30%	80%	87%
Chewings Fescue	30%	80%	97%
Kentucky Bluegrass	30%	80%	85%
Perennial Ryegrass	10%	90%	98%

4-03 OPERATION

a. Regulations. The regulations prescribed by the Secretary of War under paragraph 208.10(b)(2) give rules for the operation of levees. These rules also apply to dikes and are quoted here to avoid cross reference to the regulations.

"Levees. - Operation. - During flood periods the levee shall be patrolled continuously to locate possible sand boils or unusual wetness of the landward slope and to be certain that:

- (i) There are no indications of slides or sloughs developing;
- (ii) Wave wash or scouring action is not occurring;
- (iii) No low reaches of levees exist which may be overtopped;
- (iv) No other conditions exist which might endanger the structure.

Appropriate advance measures will be taken to insure the availability of adequate labor and materials to meet all contingencies. Immediate steps will be taken to control any condition which endangers the levee and to repair the damaged section."

4-04 EMERGENCY REPAIR METHODS FOR SCOURS

Careful watch of dikes for indication of scouring is emphasized. If any indication of scouring is observed, soundings should be taken to observe the amount and progress of the scour. Sandbagging or dumped rock will generally afford the most practicable means of combatting this condition. The open ends of sandbags, so used, must be sewed or tied after filling with earth.

4-05 EMERGENCY REPAIR METHODS FOR SAND BOILS

a. General: A sand boil is the result of a transfer of pressure head and seepage from the river, through a pervious stratum near or at the surface, to the landside of the dike. This seepage underpressure tends to push its way to the surface and actually floats the material through which it flows. No harmful effect results, provided the weight of the relatively impervious soil layer overlying the pervious stratum, in which the flow under pressure is occurring, is sufficient to counterbalance this pressure. When the soil stream overlying the pervious layer is insufficient to counterbalance the upward

pressure or when no such stratum exists, boils break through the surface on the landside wherever these weaknesses are present. The sand boil may discharge relatively clear water or the discharge may contain quantities of sand and silt, depending upon the magnitude of the pressure and size of the boil.

b. Effects of Sandboils: Sand boils can produce three distinctively different effects on the levee, depending upon the condition of flow under the levee. These three effects are illustrated in Appendix E. In Figure 1, Plate E-I, the seepage flow develops a definite pipe or tube under the levee. This breaks out at the landside toe in the form of one or more large sand boils. Unless checked, this flow causes a cavern to be developed under the levee, resulting in subsidence of the levee and subsequent overtopping. This case can most easily be recognized by slumping of the levee crown. Figure 2, Plate E-I, of Appendix E, illustrates the case where seepage flows under the levee without following a defined path, as in the case above. This flow results in one or more boils outcropping at or near the landside toe. The flow of these boils tends to undercut and ravel the slope, resulting in sloughing of the slope. Evidence of this type of failure is found in undercutting and ravelling at the landside toe. Appendix E, Plate E-I, Figure 3, shows a third type of effect of a sand boil. In this case, numerous small boils, many of which are scarcely noticeable, outcrop at or near the toe. While no boil may appear to be dangerous in itself, the consequence of the group of boils is to cause flotation of the soil, thereby reducing the shearing strength of the material at the toe, where maximum shearing strength occurs, to such an extent that failure of the slope through sliding results.

c. General Methods for Handling Sand Boils: All sand boils shall be watched closely. A sand boil which discharges clear water in a steady flow is usually not dangerous to the safety of the dike. However, if the flow of water increases or becomes cloudy, and the sand boil begins to discharge material, corrective action shall be taken immediately.

d. Treating Sand Boils:

(1) The accepted method of treating sand boils is to construct a ring of sandbags around the boil, building up a head of water within the ring sufficient to prevent further movement of sand and silt. The accepted method of ringing a sand boil, shown in Appendix E, Plate E-II, is as follows:

(i) The entire base of the sack ring is clear of debris in order to provide a watertight bond between the natural ground and the sack ring.

(ii) The sacks are then laid in a ring around the boil, with joints staggered, and with loose earth between all sacks.

(iii) The ring is carried only to a height sufficient to prevent material from being discharged. The ring should not entirely stop the flow of water, because of the probability of the excessive local pressure head causing additional ruptures of the impervious strat and boils nearby.

(iv) A "V" shaped drain constructed of two boards, or a piece of sheet metal, is then placed near the top of the ring to carry off water.

(2) Actual conditions at each sand boil will determine the exact dimensions of the ring. The diameter and height of the ring depend upon the size of the boil, and the flow of water from it. In general, the following considerations should govern:

(i) The base width should be no less than 1-1/2 times the contemplated height.

(ii) It is well to include weak ground near the boil within the ring, thereby preventing a break-through later.

(iii) The ring should be of sufficient size to permit sacking operations to keep ahead of the flow of water.

(3) Where many boils are found to exist in a given area, a ring levee of sandbags shall be constructed around the entire area and, if necessary, water pumped into the area to provide sufficient weight to counterbalance the upward pressure.

4-06 EMERGENCY REPAIR METHODS FOR SLOUGHS

During prolonged high water stages, seeping and sloughing conditions on the landside slopes may occur. Such conditions should be observed closely as to progress of seepage up the landside slope and the amount of material that is being carried by seepage. If the seep velocity becomes great enough to cause, or probably cause, erosion or sloughing of the slope, a sandbag covering should be placed on the seeping area, beginning well out from the toe and progressing up the slope. The covering should extend several feet beyond the saturated area. If the material is obtainable, the affected area should be covered with brush, straw or similar permeable material to a depth of two to four inches before placing the sandbag cover. This will permit the seep water to get away while serving as a filter to prevent loss of earth from the dike. After the covering is placed, close

observation should be maintained and additional layers of sandbags placed on the previous ones until the velocity of the seepage is reduced to a point at which the amount of material carried is negligible. Appendix E, Plate E-III, illustrates the sacking of sloughs.

4-07 RAISING EXISTING EARTH DIKES

In an emergency, time and other conditions permitting, the grade of a dike can be safely raised three feet. The methods most commonly used are sandbag topping, and lumber and sandbag topping.

a. Sandbag Topping:

(1) The sack ordinarily used for topping an earth dike shall be a grain or feed type sack (in lieu of canvas or sisal-craft type) which holds 100 pounds of grain. Smaller sacks may be used if feed sacks are not available. Grain sacks filled with about one cubic foot of earth, weighing about 100 pounds, will provide a unit about 6-inches high, one foot wide, and two feet in length.

(2) The sacks may be filled at the source of the material and hauled to the dike, or filled from stockpile or borrow areas at the dike. Conditions should determine the method employed. The same is true of filling; ie. whether power or hand methods are used.

(3) The open ends of the sacks should always face upstream or toward the riverside of the dike, and need not be sewed or tied. When the sack faces the river, the loose end should be folded under. When the sack faces upstream, the loose end should be covered by the succeeding sack.

(4) The front line of sandbags in the first layer should be laid parallel to the dike center line and remaining bags at right angles to the center line. The sandbags in the second layer are all laid at right angles to the center line, the third layer similar to the first, etc., as shown in Appendix E, Plate E-IV. All sacks shall be lapped about 1/3 each way, and well mauled or tramped into place. The sacks should be filled to two-thirds their capacity when flattened out to facilitate proper placing and prevent bursting the sack when mauled or tramped into place.

(5) Appendix E, Plate E-IV, illustrates the progressive method of increasing the dike height, and gives an approximation of the number of sacks required for various dikes of various heights. Appendix E, Plate E-V, contains pictures of a model sack dike or topping.

(6) A crew of 50 men should fill, carry and place approximately 10,000 sacks per eight-hour day, all hand labor, when the source material is within 150 feet of the point of placement. Production will depend on conditions at the site, location of storage and loading areas, and type of bag filling equipment used.

b. Lumber and Sandbag Topping: Lumber and sandbag topping is the most satisfactory method of raising low reaches of earth dike in emergencies. The chief objection is the time required to install. In putting on this topping, as well as any other topping, a careful line of levels should be run and grade stakes set in advance unless the dike top follows a dependable grade line. Two-by-four or two-by-six inch stakes should then be driven on the river side of the crown six feet apart and one-by-twelve inch boards nailed to the land side of the stakes. This wall, backed with a single tier of sandbags, will hold out at least one-foot of water. If the second foot is necessary, the layers of bags will have to be increased in number and reinforced. Sandbags are laid substantially in the manner described in the paragraphs above.

SECTION V. FLOODWALLS

5-01 DESCRIPTION

Several types of floodwalls are present in the flood protection project. Precast concrete modular walls and concrete I-walls have been constructed along the West River. Concrete I-walls and cantilever walls have been constructed along Wintergreen Brook. Appendix F, Plate 1, GENERAL PLAN, indicates the location, type, and top elevation of all floodwalls.

5-02 MAINTENANCE

a. Regulations. The regulations prescribed by the Secretary of War under paragraph 208.10(c)(1) sets forth rules that govern the maintenance of floodwalls. Applicable portions of these rules are quoted below.

"Periodic inspections shall be made by the Superintendent to be certain that:

- (1) No seepage, saturated areas, or sand boils are occurring;
- (2) No undue settlement has occurred which affects the stability of the wall or its water tightness;
- (3) No trees exist, the roots of which might extend under the wall and offer accelerated seepage paths;
- (4) The concrete has not undergone cracking, chipping, or breaking to an extent which might affect the stability of the wall or its functioning in time of flood;
- (5) There are no encroachments upon the right-of-way which might endanger the structure or hinder its functioning in time of flood;
- (6) Care is being exercised to prevent accumulation of trash and debris adjacent to walls, and to insure that no fires are being built near them;
- (7) No bank caving conditions exist riverward of the wall which might endanger its stability;
- (8) Toe drainage systems are in good working condition, and that such facilities are not becoming clogged.

Such inspection shall be made immediately prior to the beginning of the flood season, immediately following each major high water period, and otherwise at intervals not exceeding 90 days. Measures to eliminate encroachments and effect repairs found necessary by such inspections shall be undertaken immediately. All repairs shall be accomplished by methods acceptable in standard engineering practice."

b. Recommendations. To help carry out the above quoted regulations, the Division Engineer, New England Division, recommends the following:

(1) Check the expansion joints during all inspections as they will readily show any signs of settlement or movement that might occur to the walls.

(2) The expansion joint material serves to protect the water stop against damage. When the expansion joint material has deteriorated to the point where it no longer serves its purpose, the loose material should be cleaned out, care being exercised not to injure the water stop, and the joint poured full with asphalt.

5-03 OPERATION:

The regulations prescribed by the Secretary of War under paragraph 208.10(c)(2) sets forth rules that govern the operation of floodwalls during periods of flood emergencies. The following quotation from the regulations governs the operation of walls.

"Continuous patrol of the wall shall be maintained during flood periods to locate possible leakage at monolith joints or seepage underneath the wall. Floating plant or boats will not be allowed to lie against or tie up to the wall. Should it become necessary during a flood emergency to pass anchor cables over the wall, adequate measures shall be taken to protect the concrete and construction joints. Immediate steps shall be taken to correct any condition which endangers the stability of the wall."

5-04 EMERGENCY REPAIR METHODS:

The superintendent or responsible members of his organization shall take immediate action to correct any condition which endangers the stability of a wall. All such measures taken will be reported to the Division Engineer, New England Division, immediately after the flood period.

a. Sand Boils. See Section IV, paragraph 4-05, for emergency repair measures to be taken in the event that a sand boil develops.

b. Monolith joints. If vertical monolith joints show appreciable leakage, it can be controlled by dumping cinders, sand, or other such material on the river side of the wall. The dumped material will be carried into the joint by the water and plug the leak.

c. Raising grade of wall. In the event there is a danger of the walls being overtopped during a period of flooding, they can be raised reasonably safely above their present grade by the use of sand bags. One tier of sand bags placed on top of the wall will raise the grade approximately six inches. It is not recommended to attempt raising the height of the wall by more than 12 inches (two tiers of sand bags).

SECTION VI. CHANNEL IMPROVEMENTS

6-01 DESCRIPTION

Channel improvements were made along the West River and Wintergreen Brook from Blake Street to Whalley Avenue, and Park Dike was constructed along the north side of Blake Street. Improvements consisted of widening the channel, floodwalls, earth dikes, a one foot deep low flow channel, and providing shelter rock for fish habitat. A description of the location and construction of the earth dikes is contained in Section IV, Dikes, of this manual. A description of the location and construction of the floodwalls is contained in Section V, Floodwalls, of this manual.

6-02 MAINTENANCE

Paragraph 208.10(g)(1) of the prescribed regulations sets forth rules for the maintenance of channels and floodways. These rules are quoted below, followed by comments on the particular applicability of these rules to the West River project.

"Channels and Floodways. (1) Maintenance. - Periodic inspections of improved channels and floodways shall be made by the Superintendent to be certain that:

(i) The channel or floodway is clear of debris, weeds, and wild growth."

All debris and growth which tend to restrict the channel shall be removed promptly.

"(ii) The channel or floodway is not being restricted by the depositing of waste materials, building of unauthorized structures or other encroachments."

Dumping of waste materials or any types of encroachment on the channel shall be prohibited and prompt steps shall be taken to remove or have remove any such encroachments.

"(iii) The capacity of the channel is not being reduced by the formation of shoals."

Shoal areas should be removed but care should be exercised that slopes of the channel and existing banks are not undercut. Existence of shoal areas will be apparent from inspections during time of low flow.

"(iv) Banks are not being damaged by rain or wave wash, and that no sloughing of banks has occurred."

Banks damaged by rain or wave wash or sloughing shall be repaired promptly, using bankrun gravel and rock similar to that used in the original construction.

"(v) Riprap sections and deflection dikes and walls are in good condition."

Rockfill slope protection must be maintained in good condition to resist erosion. Any loss of rock due to slides, erosion or vandalism must be promptly replaced. Periodic inspections should be made of the stone slope protection for possible movement or loss of stone, and prompt corrective action taken. The rock toes should be observed closely for stability.

"Such inspections shall be made prior to the beginning of the flood season and otherwise at intervals not to exceed 90 days. Immediate steps will be taken to remedy any adverse conditions disclosed by such inspections. Measures will be taken by the Superintendent to promote the growth of grass on bank slopes and earth deflection dikes. The Superintendent shall provide for periodic repair and cleaning of debris basins, check dams, and related structures as may be necessary."

6-03 OPERATION

Paragraph 208.10(g)(2) of the prescribed regulations gives rules for operation of channels and floodways. These rules which are quoted below are self-explanatory and require no amplification with regard to the West River project.

"(2) Operation. Both banks of the channel shall be patrolled during periods of high water, and measures shall be taken to protect those reaches being attacked by the current or wave wash. Appropriate measures shall be taken to prevent the formation of jams of ice or debris. Large objects which become lodged against the bank shall be removed. The improved channel or floodway shall be thoroughly inspected immediately following each major high water period. As soon as practicable thereafter, all snags and other debris shall be removed and all damage to banks, riprap, deflection dikes and walls, drainage outlets, or other flood control structures repaired."

SECTION VII. DRAINAGE STRUCTURES & UTILITIES

7-01 DESCRIPTION

a. Drainage Structure. The main storm drainage structure within the project is a 10-foot by 10-foot by 6-foot high pre-cast concrete structure located behind the New Haven Manufacturing Company at STA 16+00 (See Appendix F, Plate 4). The structure receives storm drainage from a collection system which covers New Haven Manufacturing's roof, driveway and parking lots. A 24-inch diameter reinforced concrete pipe (RCP), which carries drainage from the west side of the building, empties into the structure. A 30-inch diameter RCP, which carries drainage from the east and south side of the building, also empties into the structure. A 36-inch diameter ductile iron pipe discharges storm drainage from the drainage structure into the West River. A sluice gate controls the discharge flow from the structure to the river. The sluice gate is equipped with a manually operated floorstand installed on top of the drainage structure. The sluice gate is closed during high river stages to prevent the river from backing up into the storm drainage system and parking lot. Diesel engine driven portable pumps are used to pump from the structure into the river whenever the sluice gate is in the closed position, and rainfall runoff is occurring over the interior area.

b. Drop Inlets with Flap Valve Discharge: There are three catch basins located on the west side of the West River. The catch basins provide storm drainage collection for parking lots, streets, and driveways. Drainage pipes penetrate the precast modular wall, and discharge flow through flap valves into the river. A description of each collection point is as follows:

(1) Drop Inlet 1: Located in the parking lot adjacent to 500 Blake Street as shown in Appendix F, Plate 2. The catch basin has a 24-inch RCP discharge into the river at STA R2+14, flap valve Invert EL. 8.20 ft, NGVD.

(2) Drop Inlet 2: Located in the driveway adjacent to STA R8+28 as shown in Appendix F, Plate 4. The catch basin has a 24-inch RCP discharge into the river at STA R8+28, flap valve Invert EL. 8.50 ft, NGVD.

(3) Drop Inlet 2A: Located in the street at the intersection of Valley Street No. 2 and West Rock Avenue as shown in Appendix F, Plate 4. The catch basin has a 18-inch RCP discharge into the river at STA R6+16, flap valve Invert EL. 9.30 ft, NGVD.

c. Drainage Pipe Below Blake Street. An 18-inch RCP storm drain runs below Blake Street. The storm drain discharges through a flap valve into the West River at the bridge abutment at STA L0-30. The flap valve is positioned very low at invert EL. 7.40 ft, NGVD. Special attention should be given to keeping the flap valve clear of debris due to its low positioning.

d. Sewer Pipe Bridge. An 8-inch cast iron sewer pipe exits the New Haven Manufacturing Company on the west side of the building, and penetrates the concrete I-wall on the West River at STA L3+34. The pipe is supported on a pipe bridge across the river, penetrates through the modular wall and connects to a sanitary sewer manhole at the end of Tour Avenue. The sewer pipe bridge is shown in Appendix F, Plate 2.

7-02 MAINTENANCE

a. Regulations. The following quotations from the regulations, paragraph 208.10(d)(1) govern the maintenance of drainage structures.

"Adequate measures shall be taken to insure that inlet and outlet channels are kept open and that trash, drift or debris is not allowed to accumulate near drainage structures. Flap gates and manually-operated gates and valves on drainage structures shall be examined, oiled and trial-operated at least once every 90 days. Where drainage structures are provided with stop log or other emergency closures, the condition of the equipment and its housing shall be inspected regularly and a trial installation of the emergency closure shall be made at least once every year. Periodic inspections shall be made by the Superintendent to be certain that:

(i) Pipes, gates, operating mechanisms, riprap, and headwalls are in good condition;

(ii) Inlet and outlet channels are open;

(iii) Care is being exercised to prevent the accumulation of trash and debris near the structures and that no fires are being built near bituminous coated pipes;

(iv) Erosion is not occurring adjacent to the structure which might endanger its water-tightness or stability.

Immediate steps will be taken to repair damage, replace missing or broken parts, or remedy adverse conditions disclosed by such inspections."

b. Storm Drain Discharge. Locations where storm drain effluent is discharged should be examined periodically to assure the discharge appears normal.

c. Drainage Structures. All drainage structures, including standard manholes, shall be inspected and cleaned out at least once a year.

d. Flap Valves. Flap valves shall be inspected to make sure that no debris is building up behind the valve which would prevent it from closing properly during flood periods. Valves shall be kept painted to maintain the metal in good condition.

e. Sluice Gate. The stem of the sluice should be kept completely coated with a water resistant lubricant to prevent corrosion and provide lubrication. The hand crank for operating the gate is attached to one of the portable pumps which are kept inside the building at the New Haven Manufacturing Company.

7-03 OPERATION

a. Regulations. The following quotations from the regulations, paragraph 208.10(d)(2) govern the operation of drainage structures:

"Whenever high water conditions impend, all gates will be inspected a short time before water reaches the invert of the pipe and any object which might prevent closure of the gate shall be removed. Automatic gates shall be closely observed until it has been ascertained that they are securely closed. Manually operated gates and valves shall be closed as necessary to prevent inflow of floodwater. All drainage structures in levees shall be inspected frequently during floods to ascertain whether seepage is taking place along the line of their contact with the embankment. Immediate steps shall be taken to correct any adverse condition."

b. Sequence of Operation. Refer to Appendix B for the sequence of operation of the drainage structures when a period of flooding is imminent.

SECTION VIII. DIESEL ENGINE DRIVEN PORTABLE PUMPS

8-01 DESCRIPTION

a. General. The flood control project is provided with three diesel engine driven portable pumps. The pumps are used to pump storm drainage from the drainage structure behind the New Haven Manufacturing Company. During high river stages, the sluice gate that controls the discharge from the drainage structure, must be closed to prevent the river from backing up into the storm drainage system. The sluice gate should be closed when the river level is within one-half foot of the top of the drainage structure and is expected to continue to rise. Once the sluice gate is closed, the storm drainage system for the New Haven Manufacturing Company is unable to discharge into the river. The portable pumps are then used to pump any rainfall runoff over the floodwall into the river. The design storm conditions would require the simultaneous operation of all three pumps. The drainage structure is equipped with openings to insert the portable pump suction hose. Discharge pipes are anchored to the concrete floodwall at the drainage structure to attach the portable pump discharge hose. The portable pumps are stored inside the building at the New Haven Manufacturing Company. Persons to contact regarding the pumps are Mr. Frank Rodgers and Mr. Stephen Ryan of New Haven Manufacturing at 203-387-2572.

b. Diesel Engine-Pump Set. The pumps are a Model 6E8P Dewatering Pump, manufactured by ITT Marlow Fluid Technology Corporation. The pump is a self-priming type with a mechanical seal that is lubricated by the liquid being pumped. The pump is direct-coupled to a Model TMD-27 Continental diesel engine. The diesel engine-pump set is mounted on an over-the-road highway trailer with DOT/ICC approved components. The approximate shipping weight is 2,500 pounds.

c. Capacity. Each pump has a capacity of 1,575 GPM at a 10 foot static suction lift and a total dynamic head of 30 feet.

d. Instrumentation. The engine is equipped with the gauges listed below.

- (1) Cooling Water Temperature Gauge
- (2) Lubrication Oil Pressure Gauge
- (3) Ammeter-Charging Circuit Gauge
- (4) Tachometer
- (5) Running Time Meter

e. Pump Serial Numbers.

- (1) Unit No. 1: 834795
- (2) Unit No. 2: 834796
- (3) Unit No. 3: 834797

f. Suction & Discharge Hose. Each diesel engine-pump set is provided with 20 linear feet of ridged suction hose, and 50 linear feet of collapsible discharge hose. Suction and discharge hose is 6-inch diameter with quick connect couplings. The hose is in 10 foot lengths. A suction strainer is provided to keep debris out of the pump.

8-02 MAINTENANCE

a. Engine Maintenance. In order to obtain maximum efficiency from the diesel engine, a definite maintenance program must be set up and followed. Haphazard maintenance will only lead to faulty engine performance and shorten engine life. All moving parts in the engine are subject to wear; however, wear can be reduced by careful operation and a planned maintenance program. In general, diesel engine operation demands careful attention to cleanliness of the air, fuel and oil and maintaining engine coolant operating temperatures of 180 to 200 degrees F. The Operator's Guide and Repair Manual for Continental diesel engines contains instructions for daily preventive maintenance and maintenance to be performed after 50, 250, 400 and 500 hours of engine operation. Section 7 from the Operator's Guide and Repair Manual is enclosed at Appendix G. Three copies of the entire manual were delivered to the city of New Haven.

(1) The diesel engine must be exercised at a minimum of once a month for a period of one hour. The engine should be operated under a load, but if not possible, the engine may be exercised at no load. THE PUMP MUST BE UNCOUPLED FROM THE ENGINE WHEN OPERATING AT NO LOAD BECAUSE THE PUMP USES THE LIQUID BEING PUMPED FOR LUBRICATION.

(2) The fuel tank should be kept full at all times to prevent condensation from forming in the tank.

(3) Check with the fuel supplier to make sure that the diesel fuel used contains stability additives to extend storage life. Diesel fuel shall be changed once a year.

b. Pump Maintenance.

(1) The pump is equipped with a mechanical shaft seal which requires no other lubrication than the liquid in which it operates.

(2) On occasion, the mechanical shaft seal may become worn and must be replaced. Follow the replacement instructions enclosed with each seal assembly.

(3) After each usage, drain all the liquid from the pump volute (pump tank). Remove the ignition wire from the spark plug before rotating the pump shaft a few turns. Rotating the shaft will help prevent rust from forming around the impeller.

(4) The shaft of the engine driven pump is supported by a heavy duty bearing in the center of the pump lantern or bracket, and by a bushing in the center of the engine flywheel. The bearing supporting the flywheel is a main bearing of the engine. It is lubricated by the engine. The ball bearing in the center of the lantern must be lubricated every 50 hours of operation. Add grease through the fittings provided until grease comes out the relief fitting or along the shaft.

(5) A complete copy of the pump Owner's and Operator's Manual is enclosed at Appendix H. Three copies of the manual were delivered to the city of New Haven.

c. Batteries.

(1) Keep batteries fully charged at all times. The specific gravity of the batteries at full charge is between 1.210 and 1.225.

(2) Keep batteries properly filled with distilled water.

(3) Keep tops of batteries and terminals clean and free from dirt, grease and moisture.

8-03 OPERATION

a. General. Detailed operational procedures are presented in the Owner's and Operator's Manual supplied with the pumps, and the Operator's Guide & Repair Manual supplied with the engines.

b. Procedure.

(1) All three portable pumps should set be up during flood operations even though conditions may not require that all three pumps be used. Space the portable pumps far enough apart to allow ample working space for laying out suction and discharge hose.

(2) Set up each pump with 20 feet of suction hose. Attach a strainer to the end of each suction hose, and

lower the suction hoses to the bottom of the drainage structure.

(3) Lay out the discharge hose running between the pump discharge and the discharge pipe anchored to the floodwall. Although each pump is supplied with 50 feet of discharge hose, use only the length of hose required. The correct amount of hose will result in long sweeping bends with no kinks when charged.

(4) Fill the pump volute with water. Although the pumps are self-priming, the pump volute must be filled with water in order for the pump to pick up a prime. The pump volute can be filled through either the cap screw on top of the volute or the pump discharge. The pump intake is equipped with a clapper valve to prevent the water from running out the volute and down the suction hose.

(5) Start the diesel engine, and allow to warm up for approximately two minutes before starting to pump.

*** CAUTION ***

THE PUMP IS DIRECT-COUPLED TO THE ENGINE, AND WILL TURN WHENEVER THE ENGINE IS RUNNING.

(6) Procedure for starting the diesel engine is as follows:

- (a) Check battery water level.
- (b) Check fuel level.
- (c) Check crankcase oil level.
- (d) Check radiator coolant level.
- (e) Turn the ignition key to the "ON" position.
- (f) Manually energize the glow plug for the length of time corresponding to the ambient temperature as listed below. The glow plug is the red button at the upper right part of the control panel.

<u>AMBIENT AIR TEMP.</u> <u>DEGREES F.</u>	<u>GLOW PLUG "ON"</u> <u>TIME/SECONDS</u>
70	15
32	20
0	30
-20	30

(g) Override the Low Oil Pressure Engine Cutout button. The button is located at the top center of the control panel. While holding in the override button, push the starter button to start the engine. Adjust the throttle to 800 to 1,200 RPM to allow the engine to circulate warm oil.

(h) After the two minute warmup, increase the engine speed to 2,200 RPM. The pump should prime itself in approximately 30 seconds.

*** CAUTION ***

DURING PUMPING OPERATIONS, THE DISCHARGE HOSE IS CARRYING A LARGE VOLUME OF WATER. A FAILURE ALONG ANY PORTION OF THE DISCHARGE HOSE WILL RESULT IN THE HOSE WHIPPING BACK AND FORTH. ANY PERSONNEL IMPACTED BY HOSE COULD RECEIVE SERIOUS OR FATAL INJURIES. KEEP PERSONNEL AWAY FROM THE AREA OF OPERATION TO THE GREATEST EXTENT POSSIBLE.

(7) Stop the engine by reducing the engine speed to idle, and allow to run at idle for approximately five minutes. Stopping the engine without a cool-down period could result in engine distortion.

(8) Disassemble suction and discharge hose. Drain pump volute. After engine has cooled, refuel as necessary. Properly store pumps and hose.

SECTION IX. MISCELLANEOUS FACILITIES

9-01 DESCRIPTION

Miscellaneous structures and facilities constructed as part of the protective works include pavements, chain link fence and railings.

9-02 MAINTENANCE

a. Regulations. Paragraph 208.10(h)(1) of the prescribed regulations governs the maintenance of miscellaneous facilities.

"Miscellaneous structures and facilities constructed as a part of the protective works and other structures and facilities which function as a part of, or affect the efficient functioning of the protective works, shall be periodically inspected by the Superintendent and appropriate maintenance measures taken. Damages or unserviceable parts shall be repaired or replaced without delay."

9-03 OPERATION

a. Regulations. Paragraph 208.10(h)(2) of the prescribed regulations governs the operation of miscellaneous facilities.

"Miscellaneous facilities shall be operated to prevent or reduce flooding during periods of high water. Those facilities constructed as a part of the protective works shall not be used for purposes other than flood protection without approval of the Division Engineer unless designed therefor."

b. Debris Removal. During a flood or heavy rainfall, observations for collection of debris should be made along the dike stone protection. Debris could block the flow of water to the drain inlets. Personnel and equipment should be available within reasonable time and distance to assist in debris removal wherever necessary.

SECTION X. OPERATIONS PLAN

10-01 PROJECT OPERATION

A plan of operation for floods is covered in Appendix B. Refer to Appendix B for stoplog and sandbag closure operations. The location and storage of sandbags, sandbag fill and stoplogs is the responsibility of the city of New Haven. Severe floods can occur at any time of year. Warning time should be available for local authorities to mobilize men and equipment for serious flood conditions. However, trained operators who are familiar with the various project features will be required to insure maximum protection operation and efficiency. Trained personnel and necessary equipment should be on call for duty at any time.

10-02 COOPERATION

Representatives of the Division Engineer, New England Division, stand ready to advise the city in the operation of the project. This in no way lessens the responsibility of the city of New Haven in the operation of the project.

SECTION XI. DRAWINGS

11-01 GENERAL

A complete set of contract drawings and specifications was furnished the city of New Haven at the time of initiation of project construction. A full size set of "As-Built" drawings, showing the project as actually constructed, was turned over to the city at the completion of construction. Reduced prints of drawings pertinent to the operation and maintenance of the project are included for reference in Appendix F.

SECTION XII. OPERATION AND MAINTENANCE MANUALS

11-01 GENERAL

A list of Operation and Maintenance Manuals for various pieces of mechanical equipment is provided below. Three copies of these manuals were furnished to the city of New Haven. These manuals should be used to supplement this O&M Manual in the operation and maintenance of the flood protection project.

a. Portable Pump: Owner's and Operator's Manual prepared by ITT Marlow Fluid Technology Corporation for their Model 6E8P Self-Priming Dewatering Pump.

b. Portable Pump Diesel Engine: Operator's Guide and Repair Manual prepared by WIS-CON Total Power Corporation for their Model TMD 27 Continental Diesel Engine.

APPENDIX A

REGULATIONS PRESCRIBED BY THE SECRETARY OF WAR

TITLE 33—NAVIGATION AND NAVIGABLE WATERS

Chapter II—Corps of Engineers, War Department

PART 208—FLOOD CONTROL REGULATIONS MAINTENANCE AND OPERATION OF FLOOD CONTROL WORKS

Pursuant to the provisions of section 3 of the Act of Congress approved June 22, 1936, as amended and supplemented (49 Stat. 1571; 50 Stat. 877; and 55 Stat. 638; 33 U. S. C. 701c; 701c-1), the following regulations are hereby prescribed to govern the maintenance and operation of flood control works:

§ 208.10 *Local flood protection works; maintenance and operation of structures and facilities*—(a) *General*. (1) The structures and facilities constructed by the United States for local flood protection shall be continuously maintained in such a manner and operated at such times and for such periods as may be necessary to obtain the maximum benefits.

(2) The State, political subdivision thereof, or other responsible local agency, which furnished assurance that it will maintain and operate flood control works in accordance with regulations prescribed by the Secretary of War, as required by law, shall appoint a permanent committee consisting of or headed by an official hereinafter called the "Superintendent," who shall be responsible for the development and maintenance of, and directly in charge of, an organization responsible for the efficient operation and maintenance of all of the structures and facilities during flood periods and for continuous inspection and maintenance of the project works during periods of low water, all without cost to the United States.

(3) A reserve supply of materials needed during a flood emergency shall be kept on hand at all times.

(4) No encroachment or trespass which will adversely affect the efficient operation or maintenance of the project works shall be permitted upon the right-of-way for the protective facilities.

(5) No improvement shall be passed over, under, or through the walls, levees, improved channels or floodways, nor shall any excavation or construction be permitted within the limits of the project right-of-way, nor shall any change be made in any feature of the works without prior determination by the District Engineer of the War Department or his authorized representative that such improvement, excavation, construction, or alteration will not adversely affect the functioning of the protective facilities. Such improvements or alterations as may be found to be desirable and permissible under the above determination shall be constructed in accordance with standard engineering practice. Advice regarding the effect of proposed improvements or alterations on the functioning of the project and information concerning methods of construction acceptable under standard engineering practice shall be obtained from the District Engineer or, if otherwise obtained, shall be submitted for his approval. Drawings or prints showing such improvements or alterations as finally constructed shall be furnished the District Engineer after completion of the work.

(6) It shall be the duty of the Superintendent to submit a semiannual report to the District Engineer covering inspection, maintenance, and operation of the protective works.

(7) The District Engineer or his authorized representatives shall have access at all times to all portions of the protective works.

(8) Maintenance measures or repairs which the District Engineer deems necessary shall be promptly taken or made.

(9) Appropriate measures shall be taken by local authorities to insure that the activities of all local organizations operating public or private facilities connected with the protective works are coordinated with those of the Superintendent's organization during flood periods.

(10) The War Department will furnish local interests with an Operation and Maintenance Manual for each completed project, or separate useful part thereof, to assist them in carrying out their obligations under these regulations.

(b) *Levees*—(1) *Maintenance*. The Superintendent shall provide at all times such maintenance as may be required to insure serviceability of the structures in time of flood. Measures shall be taken to promote the growth of sod, exterminate burrowing animals, and to provide for routine mowing of the grass and weeds, removal of wild growth and drift deposits, and repair of damage caused by erosion or other forces. Where practicable, measures shall be taken to retard bank erosion by planting of willows or other suitable growth on areas riverward of the levees. Periodic inspections shall be made by the Superintendent to insure that the above maintenance measures are being effectively carried out and, further, to be certain that:

(i) No unusual settlement, sloughing, or material loss of grade or levee cross section has taken place;

(ii) No caving has occurred on either the land side or the river side of the levee which might affect the stability of the levee section;

(iii) No seepage, saturated areas, or sand boils are occurring;

(iv) Toe drainage systems and pressure relief wells are in good working condition, and that such facilities are not becoming clogged;

(v) Drains through the levees and gates on said drafts are in good working condition;

(vi) No revetment work or riprap has been displaced, washed out, or removed;

(vii) No action is being taken, such as burning grass and weeds during inappropriate seasons, which will retard or destroy the growth of sod;

(viii) Access roads to and on the levee are being properly maintained;

(ix) Cattle guards and gates are in good condition;

(x) Crown of levee is shaped so as to drain readily, and roadway thereon, if any, is well shaped and maintained;

(xi) There is no unauthorized grazing or vehicular traffic on the levees;

(xii) Encroachments are not being made on the levee right-of-way which might endanger the structure or hinder its proper and efficient functioning during times of emergency.

Such inspections shall be made immediately prior to the beginning of the flood season; immediately following each major high water period, and otherwise at intervals not exceeding 90 days; and such intermediate times as may be necessary to insure the best possible care of

the levee. Immediate steps will be taken to correct dangerous conditions disclosed by such inspections. Regular maintenance repair measures shall be accomplished during the appropriate season as scheduled by the Superintendent.

(2) *Operation*. During flood periods the levee shall be patrolled continuously to locate possible sand boils or unusual wetness of the landward slope and to be certain that:

(i) There are no indications of slides or sloughs developing;

(ii) Wave wash or scouring action is not occurring;

(iii) No low reaches of levee exist which may be overtopped;

(iv) No other conditions exist which might endanger the structure.

Appropriate advance measures will be taken to insure the availability of adequate labor and materials to meet all contingencies. Immediate steps will be taken to control any condition which endangers the levee and to repair the damaged section.

(c) *Flood walls*—(1) *Maintenance*. Periodic inspections shall be made by the Superintendent to be certain that:

(i) No seepage, saturated areas, or sand boils are occurring;

(ii) No undue settlement has occurred which affects the stability of the wall or its water tightness;

(iii) No trees exist, the roots of which might extend under the wall and offer accelerated seepage paths;

(iv) The concrete has not undergone cracking, chipping, or breaking to an extent which might affect the stability of the wall or its water tightness;

(v) There are no encroachments upon the right-of-way which might endanger the structure or hinder its functioning in time of flood;

(vi) Care is being exercised to prevent accumulation of trash and debris adjacent to walls, and to insure that no fires are being built near them;

(vii) No bank caving conditions exist riverward of the wall which might endanger its stability;

(viii) Toe drainage systems and pressure relief wells are in good working condition, and that such facilities are not becoming clogged.

Such inspections shall be made immediately prior to the beginning of the flood season, immediately following each major high water period, and otherwise at intervals not exceeding 90 days. Measures to eliminate encroachments and effect repairs found necessary by such inspections shall be undertaken immediately. All repairs shall be accomplished by methods acceptable in standard engineering practice.

(2) *Operation*. Continuous patrol of the wall shall be maintained during flood periods to locate possible leakage at monolith joints or seepage underneath the wall. Floating plant or boats will not be allowed to lie against or tie up to the wall. Should it become necessary during a flood emergency to pass anchor cables over the wall, adequate measures shall be taken to protect the concrete and construction joints. Immediate steps shall be taken to correct any condition which endangers the stability of the wall.

(d) *Drainage structures*—(1) *Maintenance*. Adequate measures shall be taken to insure that inlet and outlet channels are kept open and that trash, drift, or debris is not allowed to accumulate near drainage structures. Flap gates and manually operated gates and valves on

drainage structures shall be examined, oiled, and trial operated at least once every 90 days. Where drainage structures are provided with stop log or other emergency closures, the condition of the equipment and its housing shall be inspected regularly and a trial installation of the emergency closure shall be made at least once each year. Periodic inspections shall be made by the Superintendent to be certain that:

(i) Pipes, gates, operating mechanism, riprap, and headwalls are in good condition;

(ii) Inlet and outlet channels are open;

(iii) Care is being exercised to prevent the accumulation of trash and debris near the structures and that no fires are being built near bituminous coated pipes;

(iv) Erosion is not occurring adjacent to the structure which might endanger its water tightness or stability.

Immediate steps will be taken to repair damage, replace missing or broken parts, or remedy adverse conditions disclosed by such inspections.

(2) *Operation.* Whenever high water conditions impend, all gates will be inspected a short time before water reaches the invert of the pipe and any object which might prevent closure of the gate shall be removed. Automatic gates shall be closely observed until it has been ascertained that they are securely closed. Manually operated gates and valves shall be closed as necessary to prevent inflow of flood water. All drainage structures in levees shall be inspected frequently during floods to ascertain whether seepage is taking place along the lines of their contact with the embankment. Immediate steps shall be taken to correct any adverse condition.

(c) *Closure structures*—(1) *Maintenance.* Closure structures for traffic openings shall be inspected by the superintendent every 90 days to be certain that:

(i) No parts are missing;

(ii) Metal parts are adequately covered with paint;

(iii) All movable parts are in satisfactory working order,

(iv) Proper closure can be made promptly when necessary;

(v) Sufficient materials are on hand for the erection of sand bag closures and that the location of such materials will be readily accessible in times of emergency.

Tools and parts shall not be removed for other use. Trial erections of one or more closure structures shall be made once each year, alternating the structures chosen so that each gate will be erected at least once in each 3-year period. Trial erection of all closure structures shall be made whenever a change is made in key operating personnel. Where railroad operation makes trial erection of a closure structure infeasible, rigorous inspection and drill of operating personnel may be substituted therefor. Trial erection of sand bag closures is not required. Closure materials will be carefully checked prior to and following flood periods, and damaged or missing parts shall be repaired or replaced immediately.

(2) *Operation.* Erection of each movable closure shall be started in sufficient time to permit completion before flood waters reach the top of the structure sill. Information regarding the proper method of erecting each individual closure structure, together with an estimate of the time required by an experienced crew to complete its erection will be given

in the Operation and Maintenance Manual which will be furnished local interests upon completion of the project. Closure structures will be inspected frequently during flood periods to ascertain that no undue leakage is occurring and that drains provided to care for ordinary leakage are functioning properly. Boats or floating plant shall not be allowed to tie up to closure structures or to discharge passengers or cargo over them.

(f) *Pumping plants*—(1) *Maintenance.* Pumping plants shall be inspected by the Superintendent at intervals not to exceed 30 days during flood seasons and 90 days during off-flood seasons to insure that all equipment is in order for instant use. At regular intervals, proper measures shall be taken to provide for cleaning plant, buildings, and equipment, repainting as necessary, and lubricating all machinery. Adequate supplies of lubricants for all types of machines, fuel for gasoline or diesel powered equipment, and flash lights or lanterns for emergency lighting shall be kept on hand at all times. Telephone service shall be maintained at pumping plants. All equipment, including switch gear, transformers, motors, pumps, valves, and gates shall be trial operated and checked at least once every 90 days. Megger tests of all insulation shall be made whenever wiring has been subjected to undue dampness and otherwise at intervals not to exceed one year. A record shall be kept showing the results of such tests. Wiring disclosed to be in an unsatisfactory condition by such tests shall be brought to a satisfactory condition or shall be promptly replaced. Diesel and gasoline engines shall be started at such intervals and allowed to run for such length of time as may be necessary to insure their serviceability in times of emergency. Only skilled electricians and mechanics shall be employed on tests and repairs. Operating personnel for the plant shall be present during tests. Any equipment removed from the station for repair or replacement shall be returned or replaced as soon as practicable and shall be trial operated after reinstallation. Repairs requiring removal of equipment from the plant shall be made during off-flood seasons insofar as practicable.

(2) *Operation.* Competent operators shall be on duty at pumping plants whenever it appears that necessity for pump operation is imminent. The operator shall thoroughly inspect, trial operate, and place in readiness all plant equipment. The operator shall be familiar with the equipment manufacturers' instructions and drawings and with the "Operating Instructions" for each station. The equipment shall be operated in accordance with the above-mentioned "Operating Instructions" and care shall be exercised that proper lubrication is being supplied all equipment, and that no overheating, undue vibration or noise is occurring. Immediately upon final recession of flood waters, the pumping station shall be thoroughly cleaned, pump house sumps flushed, and equipment thoroughly inspected, oiled and greased. A record or log of pumping plant operation shall be kept for each station, a copy of which shall be furnished the District Engineer following each flood.

(g) *Channels and floodways*—(1) *Maintenance.* Periodic inspections of improved channels and floodways shall be made by the Superintendent to be certain that:

(i) The channel or floodway is clear of debris, weeds, and wild growth;

(ii) The channel or floodway is not being restricted by the depositing of waste materials, building of unauthorized structures or other encroachments;

(iii) The capacity of the channel or floodway is not being reduced by the formation of shoals;

(iv) Banks are not being damaged by rain or wave wash, and that no sloughing of banks has occurred;

(v) Riprap sections and deflection dikes and walls are in good condition;

(vi) Approach and egress channels adjacent to the improved channel or floodway are sufficiently clear of obstructions and debris to permit proper functioning of the project works.

Such inspections shall be made prior to the beginning of the flood season and otherwise at intervals not to exceed 90 days. Immediate steps will be taken to remedy any adverse conditions disclosed by such inspections. Measures will be taken by the Superintendent to promote the growth of grass on bank slopes and earth deflection dikes. The Superintendent shall provide for periodic repair and cleaning of debris basins, check dams, and related structures as may be necessary.

(2) *Operation.* Both banks of the channel shall be patrolled during periods of high water, and measures shall be taken to protect those reaches being attacked by the current or by wave wash. Appropriate measures shall be taken to prevent the formation of jams of ice or debris. Large objects which become lodged against the bank shall be removed. The improved channel or floodway shall be thoroughly inspected immediately following each major high water period. As soon as practicable thereafter, all snags and other debris shall be removed and all damage to banks, riprap, deflection dikes and walls, drainage outlets, or other flood control structures repaired.

(h) *Miscellaneous facilities*—(1) *Maintenance.* Miscellaneous structures and facilities constructed as a part of the protective works and other structures and facilities which function as a part of, or affect the efficient functioning of the protective works, shall be periodically inspected by the Superintendent and appropriate maintenance measures taken. Damaged or unserviceable parts shall be repaired or replaced without delay. Areas used for ponding in connection with pumping plants or for temporary storage of interior run-off during flood periods shall not be allowed to become filled with silt, debris, or dumped material. The Superintendent shall take proper steps to prevent restriction of bridge openings and, where practicable, shall provide for temporary raising during floods of bridges which restrict channel capacities during high flows.

(2) *Operation.* Miscellaneous facilities shall be operated to prevent or reduce flooding during periods of high water. Those facilities constructed as a part of the protective works shall not be used for purposes other than flood protection without approval of the District Engineer unless designed therefor. (49 Stat. 1571, 50 Stat. 877; and 55 Stat. 638; 33 U.S.C. 701c; 701c-1) (Regs. 9 August 1944, CE SPEWF)

[SEAL]

J. A. ULIO,
Major General,
The Adjutant General.

[P. R. Doc. 44-12285; Filed, August 16, 1944;
9:44 a. m.]

APPENDIX B
STANDARD OPERATING PROCEDURES
DURING FLOOD PERIODS

APPENDIX B
STANDARD OPERATING PROCEDURES
DURING FLOOD PERIODS

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APPENDIX B

STANDARD OPERATING PROCEDURES DURING FLOOD PERIODS

SCOPE

1. GENERAL

This appendix prescribes details for the operation of flood control features of the New Haven, Connecticut (West River) Local Protection Project prior to and during flood periods. Climatologic and hydrologic data are included for background information.

RESPONSIBILITIES

2. CITY OF NEW HAVEN

The city is responsible for the entire flood protection works (see plate B-1 for project location). Instructions for the operation are presented in this appendix. Areas of responsibility include:

- a. Complete operation of the project during flood periods.
- b. Determining phases of preparedness, mobilization and operations based on:
 - (1) National Weather Service river and weather forecasts.
 - (2) River stage at upstream end of the project at West River and Wintergreen Brook (Blake Street).
 - (3) River level at the confluence of West River and Wintergreen Brook at the drainage structure.
- c. Training personnel in specific duties and holding periodic practice sessions to insure efficient and effective maintenance and operation.
- d. Maintaining adequate contact with the National Weather Service to obtain weather and flood forecasts.

3. CORPS OF ENGINEERS

The Reservoir Control Center (RCC) of the Corps of Engineers continually monitors rainfall and runoff conditions in much of New England. This climatologic and hydrologic information is available. RCC will review operational procedures following

major floods to determine whether the prescribed regulation instructions need revision.

4. NATIONAL WEATHER SERVICE

The National Weather Service (NWS) has no direct role in the operation of the project. However, it has the responsibility of issuing weather and flood forecasts to the general public. Flood forecasts for the West River Watershed are issued by the Northeast River Forecast Center at Bloomfield, Connecticut.

CLIMATOLOGY

5. GENERAL

The West River basin has a variable climate and frequently experiences periods of heavy precipitation produced by local thunderstorms, or larger weather systems of tropical and extratropical origin moving up the Atlantic coast. The basin also lies in the path of the prevailing "westerlies" which generally travel across the country in an easterly or northeasterly direction producing frequent weather changes. Due to its proximity to the Atlantic Ocean and Long Island Sound, the basin generally escapes the severity of cold and depth of snowfall experienced further inland.

6. TEMPERATURE

The average annual temperature in the West River basin is approximately 50 degrees Fahrenheit varying from an average of 73 degrees in July to 29 degrees in January. Within the watershed, temperatures can vary 5 degrees to 15 degrees between the coast and the higher elevations in the north. Recorded temperature extremes have varied from occasional highs of over 100 degrees Fahrenheit to infrequent lows below minus 5 degrees Fahrenheit. Mean, maximum, and minimum monthly temperatures at New Haven, Connecticut are listed in table B-1.

7. PRECIPITATION

The average annual precipitation in the West River watershed is approximately 46 inches distributed uniformly throughout the year. However, monthly extremes range from a high of almost 14 inches in June 1982 to a low of 0.12 inches in June 1949. Mean, maximum, and minimum monthly precipitation at New Haven are listed in table B-2. Some flood-related storm rainfalls are discussed in paragraph 10.

TABLE B-1

MONTHLY TEMPERATURE
AT NEW HAVEN, CONNECTICUT
(111 Years of Record Through 1982)

<u>Month</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
January	29.0	65	-8
February	29.5	60	-5
March	37.3	74	1
April	47.5	83	17
May	58.1	86	32
June	67.2	96	40
July	72.7	100	47
August	70.9	100	45
September	64.5	91	33
October	54.0	84	24
November	43.2	75	14
December	32.8	63	-3
Annual	50.5	100	-8

TABLE B-2

MONTHLY PRECIPITATION
AT NEW HAVEN, CONNECTICUT
 (111 Years of Record Through 1982)

<u>Month</u>	<u>Mean</u>	<u>Percent</u>	<u>Maximum</u>	<u>Minimum</u>
	(Inch)	of Annual	(Inch)	(Inch)
January	3.80	8.4	14.58	0.25
February	3.64	8.1	6.40	1.15
March	4.23	9.4	10.78	1.05
April	3.79	8.4	6.97	1.56
May	3.67	8.1	7.77	0.77
June	3.34	7.4	14.42	0.12
July	3.86	8.5	8.73	0.55
August	4.09	9.1	10.95	0.37
September	3.55	7.8	9.99	0.64
October	3.54	7.8	10.06	0.26
November	3.75	8.3	8.58	0.37
December	3.93	8.7	8.99	0.98
Annual	45.17		59.63	27.68

8. SNOWFALL AND SNOW COVER

The average annual snowfall in New Haven, at the lower end of the watershed, is approximately 33 inches. Greater amounts of snowfall would be expected at the higher elevation in the north. There are no Corps snow survey courses in the West River basin, and therefore no recorded data on water equivalents. The nearest Corps of Engineers snow course is at Thomaston Dam, Thomaston, Connecticut in the Naugatuck River basin, approximately 24 miles inland. The water content of the snow cover at this course would probably be most representative of upper portions of the West River watershed. The water equivalent of the snowpack is usually highest in mid to late February with an average of about 1.2 inches with maximums as high as 6 inches. Snowfall and snow cover data are listed in tables B-3 and B-4, respectively.

9. RUNOFF

The West River is ungaged but it is expected, based on gaged streams in the area, that average annual runoff is about 24 inches or about 50 percent of average annual precipitation. This runoff would produce an average flow of about 50 cfs from the 29.4 square miles of watershed above tidewater. During design studies, the Corps of Engineers funded the USGS to install, calibrate and maintain some temporary peak stage-discharge gages on the West River in, and just downstream of, the study area in New Haven. The gages are no longer in operation; however, the highest stage-flow occurred on 30 May 1984 when the peak flow at Whalley Avenue was 1,000 cfs and the river levels upstream and downstream of the bridge were 7.90 feet and 7.85 feet NGVD, respectively.

10. FLOOD HISTORY

a. General. Although there are no systematic streamflow records for the West River, it is believed the two greatest floods in recent history occurred in October 1955 and June 1982.

b. October 1955. The October 1955 flood was the result of almost 9 inches of rainfall over the West River basin between 14 and 17 October, with a maximum 24-hour rainfall of about 6 inches on the 15th and 16th. The frequency of a 24-hour rainfall of 6 inches is about 3 percent (35-yr.) based on U.S. Weather Bureau Technical Paper #40. Antecedent conditions were also high as a result of heavy rainfall approximately 2 months earlier associated with the August 1955 hurricane "Diane" storm. The New Haven Water Company computed an October 1955 peak discharge from Lake Dawson (D.A. = 13.9 square miles) of 1,400 cfs. In an engineering report done by the New Haven Water Company and included in the August 1979 Phase I Inspection Report for Lake Dawson Dam (CT00319) consultants for the State of Connecticut

TABLE B-3

MEAN MONTHLY SNOWFALL
AT NEW HAVEN, CONNECTICUT
(35 Year Record Through 1983)

<u>Month</u>	<u>Inches</u>
January	8.8
February	9.7
March	5.9
April	0.9
May	0
June	0
July	0
August	0
September	0
October	0
November	0.8
December	7.1
Annual	33.2

TABLE B-4

WATER EQUIVALENT OF SNOW COVER (IN INCHES)
THOMASTON DAM*
NAUGATUCK RIVER, CONNECTICUT
(1962-1983)

<u>Date</u>	<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
15 January	1.2	4.3	0
31 January	0.4	3.7	0
07 February	0.6	4.0	0
15 February	1.8	6.0	0
08 February	0.6	5.8	0
07 March	1.0	5.2	0
14 March	0.8	4.0	0
28 March	0.4	3.1	0

*Thomaston Dam is located approximately 24 miles inland from New Haven, Connecticut

reported an estimated West River flow of 3,500 cfs at Whalley Avenue in New Haven (D.A. = 29.4 square miles).

c. June 1982. The greatest flood known on the West River was the result of almost 13 inches of rainfall over the basin between 4 and 6 June 1982. Maximum 24-hour rainfall associated with the storm was about 9.4 inches on the 5th and 6th which is in excess of the 1 percent chance (100-yr.) 24-hour rainfall of 7.1 inches, reported in U.S. Weather Bureau T.P.#40. Based on reported peak levels at Lake Dawson the peak discharge was estimated to be 3,800 cfs. The peak flow of the West River at Whalley Avenue was about 6,800 cfs based on: (1) a drainage area ratio to the 0.7 exponential power factor applied to the discharge at Lake Dawson, (2) experienced flood levels and backwater computations made at New Haven and (3) observations and computations made by the USGS of the flood hydraulics at the Whalley Avenue bridge.

11. FLOOD DISCHARGE FREQUENCIES

A peak discharge frequency curve of the West River at Whalley Avenue was developed based on the experienced June 1982 and October 1955 flood flows compared with the flows at gaged streams in the region and the statistical analysis of the records of those gaged streams. The two gaged streams used were the Quinnipiac River at Wallingford, Connecticut, with a drainage area of 110 square miles and 52 years of record, and the Eight Mile River at North Plains, Connecticut, with a drainage area of 20 square miles and 45 years of record. A comparison was also made with recorded flows on the neighboring Mill River in Hamden, Connecticut (with a drainage area of 24.5 square miles, but only 8 years of record).

Frequency analyses of the two long term gaging records were performed using a Log Pearson Type III distribution in accordance with the US Water Resources Council Bulletin 17B, "Guidelines for Determining Floodflow Frequency", revised September 1981. Adopted discharge data are listed in table B-5.

12. TIDE FREQUENCY

The West River, which empties into Long Island Sound at New Haven Harbor, is a tidal river for its last 3 miles. Table 6 lists pertinent tide level data for New Haven, including estimated storm tide-stage frequencies based on studies done by the Hydraulics and Water Quality Branch, Water Control Division, New England Division. In frequency studies the tide levels at New Haven Harbor were correlated with data from Bridgeport Harbor (approximately 14 miles west of New Haven) where long term tide records were available. The mean tide range at New Haven Harbor is 6.2 feet with the mean high tide of 3.5 feet NGVD. The

TABLE B-5

PEAK DISCHARGE DATA
 (IN CFS)
WEST RIVER
NEW HAVEN, CONNECTICUT

	Corps Post 1982 <u>Walley Ave.</u> (DA = 29.4 mi)	Corps Post 1982 <u>Mite-West R.</u> (DA = 18.8 mi)	Corps Post 1982 <u>Mite-Wintergreen Br</u> (DA = 10.6 mi)
10% (10-yr)	2750	1670	1230
2% (50-yr)	4800	2760	2040
1% (100-yr)	5850	3370	2480
0.5% (200-yr)	6800	3900	2900

highest observed storm tides of record occurred with the September 1938 and August 1954 hurricanes, each having tide levels of 9.8 feet NGVD. High tide levels during the June 1982 flood were approximately 4.5 feet NGVD on 5 June 1982. Pertinent tide data information is listed in table B-6.

13. TAILWATER LEVELS

Flood levels in the project area are a function of both peak discharge in the West River and the coincident downstream tailwater level below Whalley Avenue. As previously stated, the West River enters tidewater just below Whalley Avenue, about 3 miles upstream of New Haven Harbor where there is a tide gate structure. The tide gate has twelve 5-foot wide by 7.3 feet high bays equipped with hinged gates. The invert of the bays is elevation -1.55 feet NGVD and the top of structure is 8.45 feet NGVD. During normal tides and riverflow, the gates close on incoming tide, and fresh water flows are stored. On outgoing tides, the gates open and stored waters are released. The structure thus serves to minimize salt water intrusions and tidal fluctuations in the basin during normal tide and flow conditions. However, during abnormal flow or tide conditions, the tailwater level at Whalley Avenue is a function of: (a) peak West River discharge and hydraulic losses between Whalley Avenue and downstream storage, (b) downstream storage level and (c) tide conditions in Long Island Sound. The probable coincidence of the various conditions governing tailwater level is quite indeterminate.

Tailwater flood levels were scoped, by cursory flood hydrograph routings, for a range of flood hydrograph magnitudes and coincident storm tide conditions. The storage basin area is approximately 200 to 250 acres in area, and, therefore; when riverflows exceed about 3,000 cfs, the basin storage level would rise about as fast as the incoming tide level in Long Island. Though it is highly improbable that a major floodflow even would occur coincident with a major storm tide event, i.e., 50-year discharge coincident with 50-year tide, it is quite probable that during a major storm tide there could be appreciable riverflow, i.e., 3,000 cfs or more, as a result of accompanying storm rainfall. Therefore, basin levels could approximate ocean levels during severe storm tides. In comparison, under conditions of high riverflow with moderate storm tides, the hydraulic capacity of the gate structure and basin storage was found to govern with coincident tide level in the sound being less of a factor. Comparative tailwater levels for major floodflows with moderate storm tides, and major storm tides with moderate floodflows are listed in table B-7. Also listed in table B-7 are the adopted tailwater-frequency levels used as starting levels 2,500 feet downstream of Whalley Avenue in evaluating flood control measures upstream of Whalley Avenue.

TABLE B-6

PERTINENT TIDE DATA
NEW HAVEN, CONNECTICUT

Tide

Mean Tide Range	6.2 Ft.
Mean High Tide	3.7 Ft. NGVD
Mean Spring Tide	4.2 Ft. NGVD
1 Year	5.5 Ft. NGVD
10 Year	8.6 Ft. NGVD
50 Year	10.0 Ft. NGVD
100 Year	10.6 Ft. NGVD

14. ANALYSIS OF FLOODS

The West River watershed is a coastal basin with a total watershed area of approximately 36 square miles. The river originates in the town of Bethany, Connecticut and flows at a moderately steep gradient for approximately 16.7 miles in a southeasterly direction, with a total fall of about 650 feet. There are two principle tributaries to the West River. Sargent River has a drainage area of 15.8 square miles and Wintergreen Brook has a drainage area of 10.7 square miles. There are a total of nine reservoirs in the West River basin. Five are for water supply, two are mainly recreational water bodies and two are small flood control detention reservoirs built by the Soil Conservative Service. Flood development within this watershed is rapid with resulting high discharge. Results of an analysis of the record June 1982 flood, showed that a peak discharge of 7,145 cfs was experienced at New Haven. This flood was estimated to be a 200-year event. Flood frequency elevations (at the confluence of West River and Wintergreen Brook) and associated discharges are shown in table B-8.

15. DESIGN FLOOD

The improved channels, walls and dikes along the West River and Wintergreen Brook were designed for the adopted 50-year flood discharge of 4,800 cfs plus design freeboard with a starting downstream tailwater elevation of 9.0 feet NGVD. The project design discharge is 40 percent greater than the experienced October 1955 event, but 30 percent less than the experienced June 1982 flood of record. A minimum of 2 feet of freeboard is provided on walls, and 3 feet on dikes.

DESCRIPTION OF OPERATIONAL ELEMENTS

16. GENERAL

This section briefly describes the elements of the flood protection works and related equipment that town personnel will operate prior to and during floods. These elements consist of three portable interior drainage pumps, a sluice gate structure, stoplog, and sandbags closures. A general plan of the interior drainage appurtenances are shown on plate B-3.

17. INTERIOR DRAINAGE SYSTEM

a. General. The system of low freeboard dikes and walls will intercept surface runoff from three interior areas totalling about 18 acres. However, project design flood levels under improved channel conditions are, for the most part, at or below interior ground elevations, permitting interior drainage by gravity outlets, with the exception of area 1, which is described

TABLE B-7

ESTIMATED WEST RIVER TAILWATER LEVELS
2,500 FEET DOWNSTREAM OF
WHALLEY AVENUE

<u>Frequency</u> (%) (yrs)		<u>Tailwater with Major</u> <u>River Flood and</u> <u>Moderate Storm Tide</u> (cfs) (ft. NGVD)		<u>Tailwater with</u> <u>Major Storm Tide &</u> <u>Moderate Floodflow</u> (ft. NGVD)	<u>Adopted</u> <u>Tailwater</u> <u>Frequency</u> (ft NGVD)
0.5	200	6,800	11.4	11.4	11.4
1.0	100	5,800	10.0	10.5	10.0
2.0	50	4,800	8.2	9.8	9.0
10.	10	2,900	5.5	8.4	7.0
50.	2	1,500	4.5	6.7	6.0

TABLE B-8

FREQUENCY OF FLOODING
WEST RIVER AT CONFLUENCE
WITH WINTERGREEN BROOK

<u>Estimated</u> <u>Frequency</u> (years)	<u>Water Surface</u> <u>Elevation</u> (ft. NGVD)	<u>Discharge</u> (cfs)
SPF	19.8	13,620
100	15.0	5,850
50	13.1	4,800
20	11.8	3,700
10	10.4	2,750
5	9.8	2,300
2	8.4	1,500

below. Provisions are made for discharging intercepted interior surface drainage through the line of protection or intercepted and conveyed in a collector to a common gated outlet and then through the line of protection.

b. Area 1. It is the only interior area that is below design river level under improved conditions. Area 1 lies north of the confluence of the West River and Wintergreen Brook. It is bounded by the West River on the west, Wintergreen Brook on the southeast and Blake Street on the north. Blake Street acts as the northerly divide diverting flows east and west to the streams. Area 1 is 9.6 acres in size, extremely flat, and comprised of mostly impervious industrial buildings and associated paved lots. Natural drainage is to the southwest to the confluence of the two streams. Minimum ground elevation is about elevation 11 feet NGVD with minimum first floor elevation 12 feet NGVD. Design flood elevation at the confluence is elevation 12.8 and top of protection is elevation 16. The frequency of river level to minimum ground elevation is 10 percent (10-year event). Maximum emergency ponding capacity between elevation 11 and 12 is about 1.1 acre-feet, equivalent to 1.4 inches of runoff from the interior area. At the confluence of the West River and Wintergreen Brook a drainage structure is provided with a 36 inch diameter drain through the line of protection. This drain structure is equipped with a sluice gate and serves as a collection point for interior runoff.

18. PORTABLE PUMPS

The project is equipped with three portable interior drainage pumps. Each of the pumps has a discharge capacity of 1,575 gpm for a total pumping capability of 4,725 gpm (10 cfs). This is equivalent to a total interior runoff rate of 1.0 inch per hour. When pumping is required, the suction hoses on the portable pumps will be placed within the drain inlet along the 36 inch gravity conduit. This drain inlet is used as the "sump" for pumping purposes (see location on plate B-3).

19. STOPLOG AND SANDBAG CLOSURES

Several openings through the floodwall for vehicular traffic will be closed by a wooden stoplog gate prior to the river reaching flood stage (see plates B-1 and B-2). Table B-9 presents pertinent data concerning closures.

TABLE B-9

STOPLOG AND SAND BAG CLOSURES

LOCATION

West River at Blake Street

Right Bank Closures - Area A

- A. Stoplog (24 Ft. W x 2 Ft. High)
- B. Stoplog (24 Ft. W x 2 Ft. High)
- C. Sandbag (5 Ft. W x 2 Ft. High)

Left Bank

- D. Sandbag over Blake St. (60 Ft. W x 2.5 Ft. High) - Area B
- E. Sandbag (68 Ft. W x 1.5 Ft. High) - Area C

Wintergreen Brook at Blake Street - Area D

- F. Sandbag (63 Ft. W x 1.5 Ft. High)
- G. Sandbag (4 Ft. W x 1.5 Ft. High)

OPERATIONAL CONSIDERATIONS

20. GENERAL

There are numerous items that must be considered in prescribing operational procedures for this project. The principal considerations are:

- a. National Weather Service Forecasts of possible floodings.
- b. River and Brook levels at the project and upstream of Blake Street.
- c. Time needed to mobilize personnel associated with operation of project.
- d. Activation time required for the portable pumps, gravity conduit sluice gate, stoplog, and sandbag closure.
- e. Observations along the walls, dikes and stoplog closures during floodflows to detect any leaks, obstructions or problem areas.

21. MOBILIZATION

- a. Portable Pumps. The time required to mobilize personnel and activate the portable pumps for a flood is dependent on many items and presently can only be estimated. In order to provide sufficient time to overcome foreseeable weather, mechanical or personnel difficulties, mobilization and staffing of the portable pumps will be completed when the river level rises to within 1 foot below the top of the drainage structure and continues to rise.

It is estimated that a minimum of three persons are required to mobilize and activate the portable pumps. Once the pumps are activated it is estimated that one person would be needed to operate the pumps, and maintain an operations log while the other two persons lend support to additional crews.

b. Stoplog and Sandbag Closure. Mobilization of the crew for stoplog vehicle access gate closure will begin when the rising river and brook stages are within 1 foot of the low chord elevation of Blake Street bridges on the West River and Wintergreen Brook. It is estimated that a crew of four persons will be required to place the wooden stoplogs within the gate opening while placing sandbags on the riverside of the gate. It is anticipated that one of the additional persons in the pump crew would be part of this stoplog gate crew once the pumps have been activated. Sandbag closures will require two crews of four along with a truck with required material to make the necessary closures.

During flood periods the protective works shall be patrolled continuously to locate possible leakage at dikes, floodwalls and all closures. Crews should be thoroughly instructed as to their duties, what they are to watch for and the exact limit of their patrol.

OPERATIONAL PHASES AND INSTRUCTIONS FOR FLOODS

22. OPERATIONAL PHASES

The project superintendent should be watchful during periods of heavy rainfall that could result in significant runoff. The operational functions have been divided into "phases" to assure a clear delineation of actions to be taken prior to and during flood conditions and are outlined below:

Phase 1 - Project Superintendent alerts crew for possible flood operations.

Phase 2 - Begin staffing operations.

Phase 3 - Begin flood operations.

Phase 4 - Cessation.

23. INSTRUCTIONS

a. General. This section contains instructions to be followed by personnel operating the project during flood periods. The instructions have been summarized and are shown on plate B-4.

b. Phase 1. The National Weather Service issues a "flood watch" for the region of Connecticut including the West River Watershed. The project superintendent will alert all personnel connected with the operation of the project and will closely follow National Weather Service reports. The superintendent will inform his crew to commence recording water levels at the drainage structure and at the Blake Street Bridges on West River and Wintergreen Brook at least four times a day. Phase 1 may also be initiated for (1) prolonged periods of heavy rain and/or melting snow with warm temperatures, or (2) river level reading at the drainage structure of 2 feet below the top (3) river level is within 2 feet of the low chord at Blake Street Bridge and rising.

c. Phase 2. Position portable pumps, and prepare for activation, when the following conditions develop.

1. The National Weather Service forecasts flood stages on the West River or neighboring coastal streams.
2. The river level is within 1 foot of the top of the drainage structure and rising.

Phase 2 includes the following operations:

1. Position all portable pumps, and prepare for activation, by placing suction hoses within the drainage structure, located near the floodwall at the confluence of West River and Wintergreen Brook.

2. Mobilize all work crews.

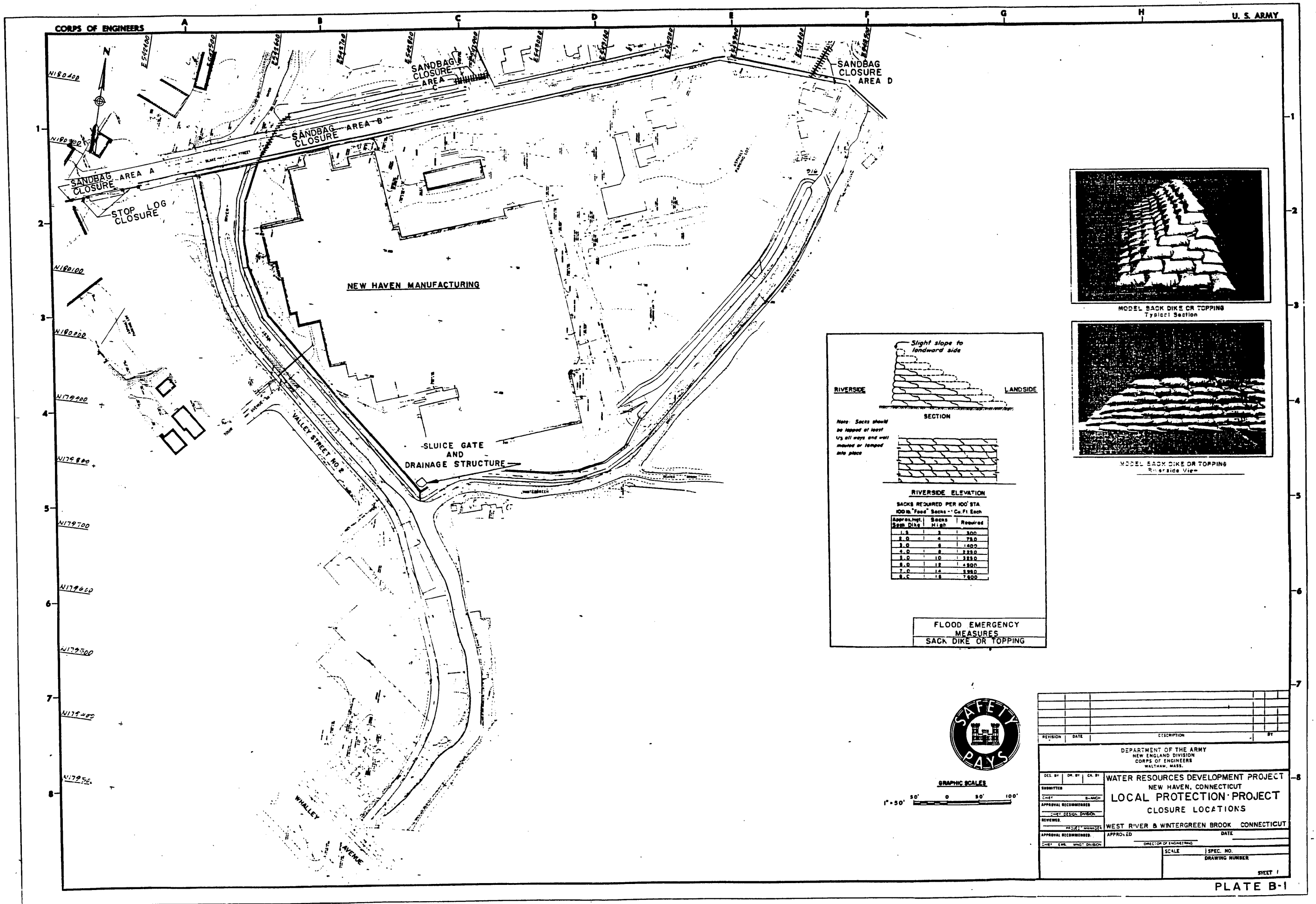
d. Phase 3. Activate the portable pumps when the river level is within one-half foot of the top of the drainage structure and is expected to continue to rise. Check gravity conduit sluice gate to insure it is fully closed. Operate pumps as needed. Begin placing stoplogs and sandbags as necessary.

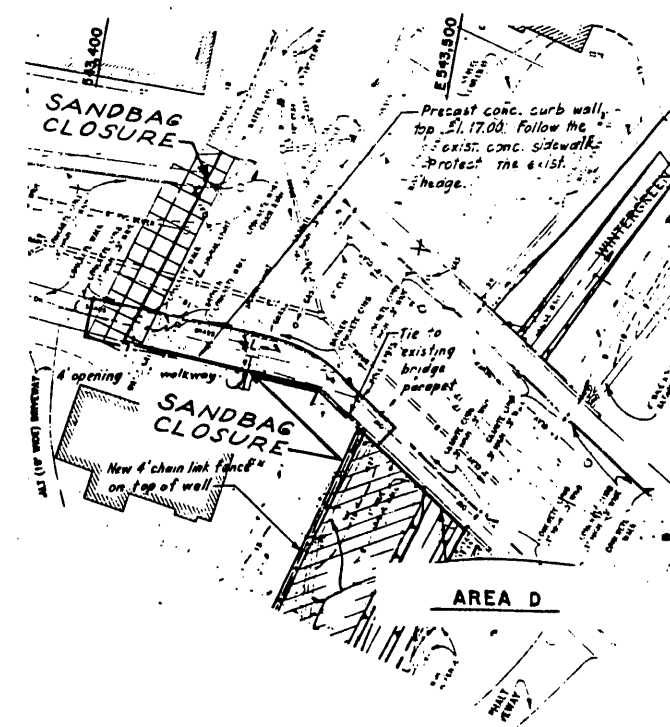
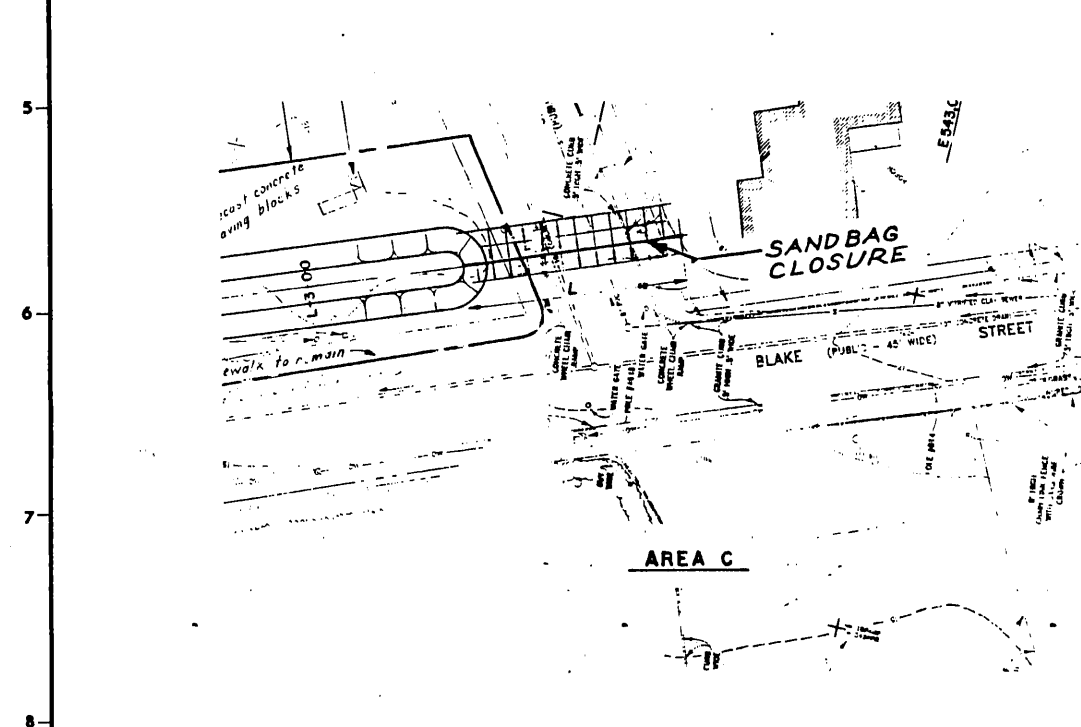
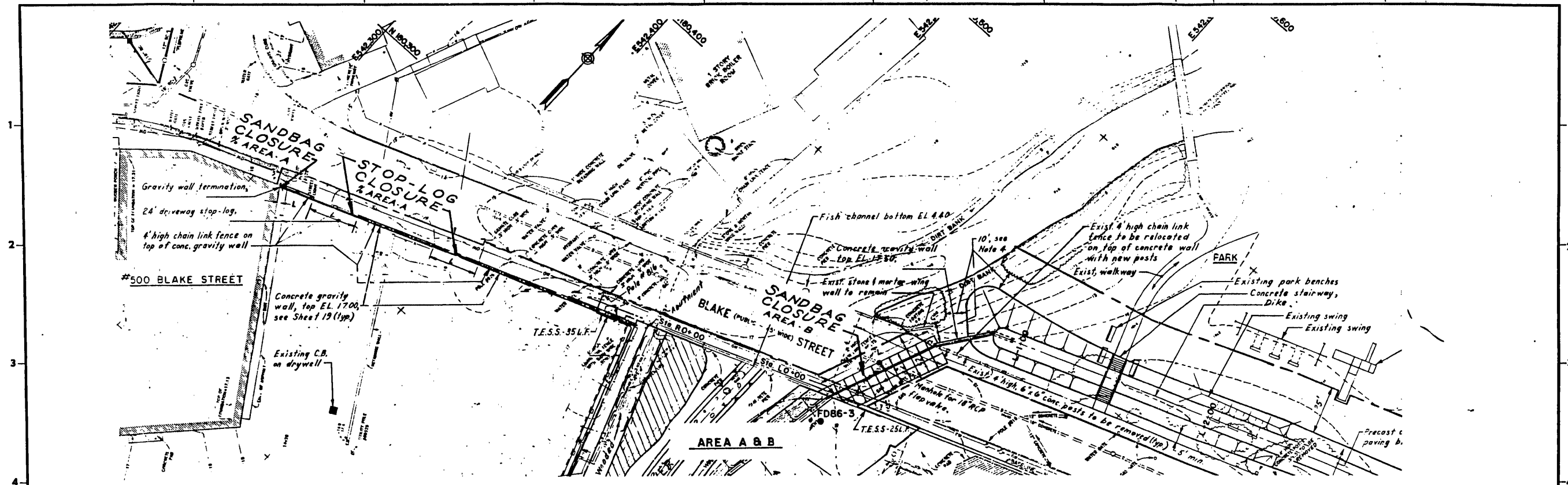
e. Phase 4. Deactivate pumping as needed, or when the river level recedes to 6 feet below top of the flood wall near drainage structure and open sluice gate. Remove stoplogs and sandbags as needed while the river level falls. Operation will revert to phase 1 until the river level falls below 2 feet below top of drainage structure.

For sample flood operations refer to plate B-5 which demonstrates project operation for a flood 30 percent less than the June 1982 record event.

24. REPORTS

Prior to and during the operation of the project, information pertinent to a flood operation will be entered in a log of reports as shown on plate B-6. The flood report will include pumping operations, sluice gate closure, hourly river levels at the Blake Street bridges, a log of stoplog and sandbag closures and any problems or observations that would help in evaluating the operational procedures and prescribed regulation. Project river level readings are necessary in order to determine the discharge associated with a particular flood as well as aid the Reservoir Control Center, Corps of Engineers, in their evaluation of flood control benefits afforded by the project during flood events. Following the flood event the completed "logs", along with any other notes/observations made during the flood event, should be forwarded to the Reservoir Control Center, U.S. Army Corps of Engineers, New England Division, Waltham, Massachusetts, 02254-9149.



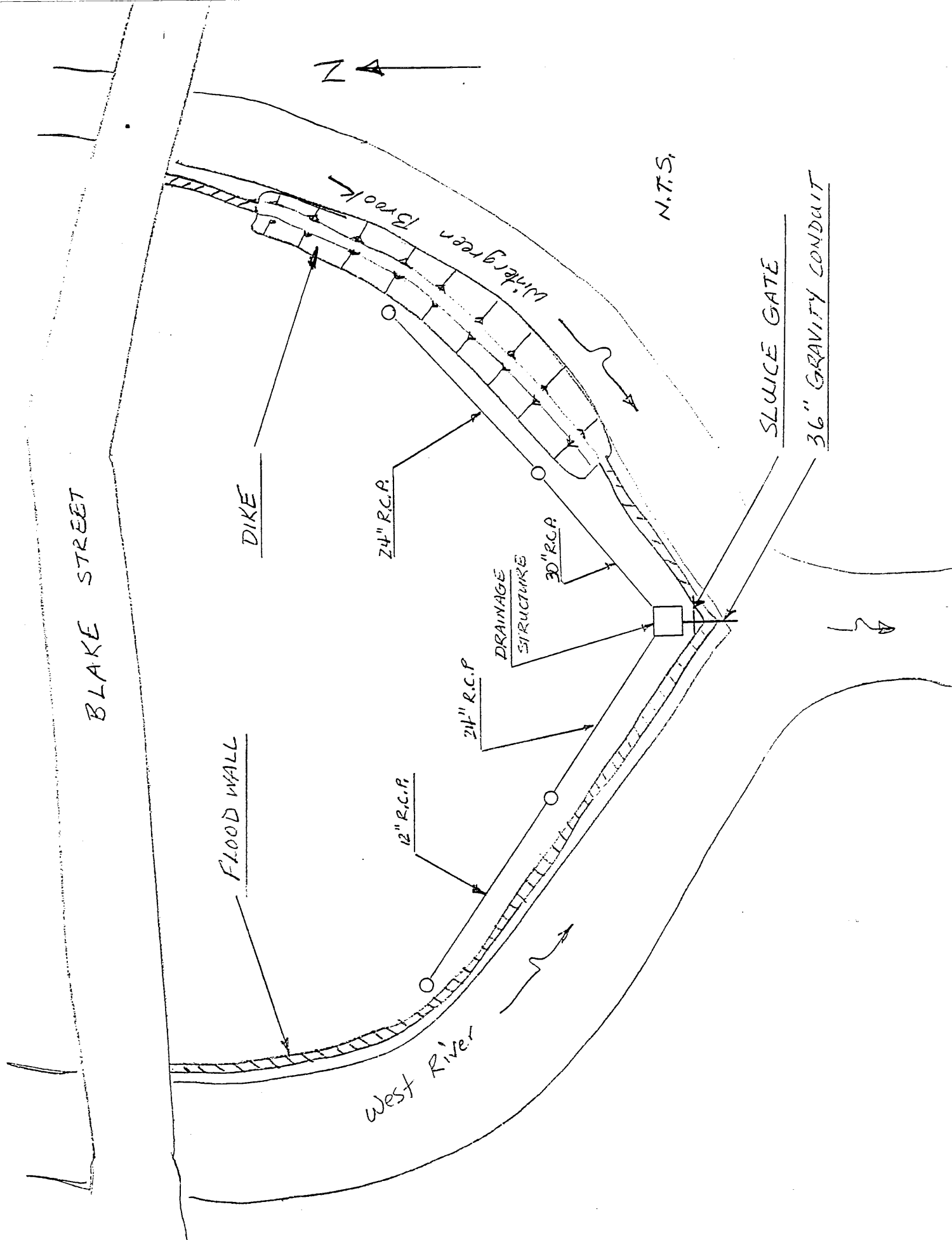


AREA	STRUCTURE	LENGTH (L)	TOP ELEV.	APPROX. HEIGHT
A	SANDBAG (2) STOP-LOG	5' 24'	17.0 17.0	2'± 2'±
B	SANDBAG	60'±	17.5	2.5'±
C	SANDBAG	68'±	18.5	3.5'±
D	SANDBAG SAND-LOG SAND-LOG	63'± 4'	17.0 17.0	1.5'± 1.5'±



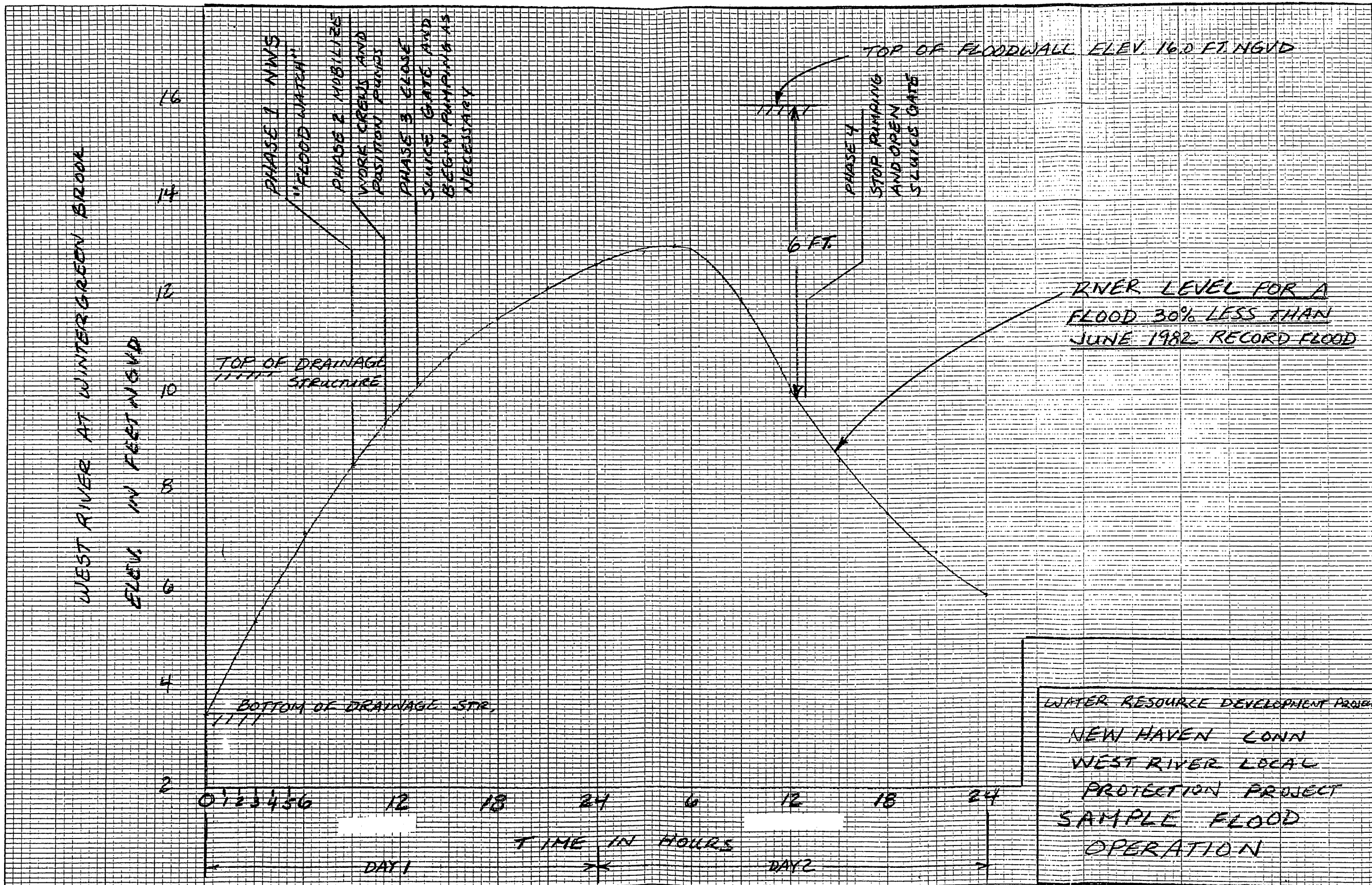
GRAPHIC SCALES

REVISION	DATE	DESCRIPTION	BY
DEPARTMENT OF THE ARMY NEW ENGLAND DIVISION CORPS OF ENGINEERS WALTHAM, MASS.			
WATER RESOURCES DEVELOPMENT PROJECT NEW HAVEN, CONNECTICUT LOCAL PROTECTION PROJECT CLOSURE LOCATIONS			
WEST RIVER & WINTERGREEN BROOK, CONNECTICUT			
SUBMITTED		DATE	
APPROVAL RECOMMENDED		APPROVED	
REVIEWED		DATE	
APPROVAL RECOMMENDED		APPROVED	
CHIEF, CIV. ENGR. DIVISION		DIRECTOR OF ENGINEERING	
SCALE		SPEC. NO.	
DRAWING NUMBER		SHEET 2	



STANDARD OPERATING PROCEDURE FOR FLOODS
NEW HAVEN, CONNECTICUT LOCAL PROTECTION PROJECT

PHASE		CONDITION	PERSONNEL	GRAVITY CONDUIT GATE	PUMPS
		Normal	Inactive	Gravity Conduit Open	Idle
1	ALERTING	a. National Weather Service (NWS) issues a "flood watch" for this region of Connecticut b. Heavy rains continuing over project area c. River level two feet below low chord of Blake Street bridges d. River level two feet below top of drainage structure	All personnel will be alerted	Normal	Idle
2	STAFFING	a. NWS issues a "flood warning" for West River/Coastal Connecticut Rivers b. River level within 1 foot of the low chord at Blake Street bridges & 1 foot from top of drainage structure	Mobilize & Position portable pumps Mobilize all work crews	Normal	Idle
3	OPERATING	River level one-half foot from top of drainage structure and water hitting low chord of Blake Street bridges	a. Close 36" gravity conduit gate & start pumping as needed b. Begin placing sand-bags & stoplogs	Closed	Operating
4	CESSATION	River level 6 feet from top of floodwall at drainage structure & 2 or more feet below low chord at Blake St.	a. Stop pumping & open gate on gravity drain b. Remove stoplogs & Sand-bags	Open	Stop
1		Phase 1 remains in effect until flooding is no longer a threat to area	All personnel remain on alert status	Normal	Idle



NEW HAVEN LOCAL PROTECTION PROJECT
OPERATION LOG

Time	River Level Blake St. (Feet below Low Chord)	Brook Level Blake St. (Feet below Low Chord)	Water Level in Drainage St. (Feet below top)	Pumps			Remarks Inc- lude gravity gate closure & Stoplog/ Sandbag closure
				No	No2	No3	

APPENDIX C
INSPECTION REPORT FORMS

APPENDIX C
INSPECTION REPORT FORMS

Table of Contents

<u>Page</u>	<u>Item</u>
C-1	Designation of Superintendent
C-2	Local Flood Protection Inspection Report
C-4	Inspection Report - Check List

DESIGNATION OF SUPERINTENDENT

Name of Project: _____

Location: _____

MAINTAINING MUNICIPAL AGENCY:

Agency: _____

Address: _____ Tel. No. _____

"SUPERINTENDENT" - as required by Section 208.10 (a)(2),
Chap. II, Title 33 USC.

Name & Title: _____

Employed by: _____

Business Address: _____

Business Tel. No.: _____

Nights, Sundays, Address: _____

Nights, Sundays, Tel. No.: _____

Remarks:

Signed: _____

Title: _____

Date: _____

NOTE: To be submitted and updated as necessary by the responsible agency which will maintain and operate the works in accordance with regulations prescribed by the Secretary of the Army as required by law (Title 33, Chap. 208, Sec. 11, USC).

LOCAL FLOOD PROTECTION PROJECT INSPECTION REPORT

Project: _____

Maintaining Agency: _____

Type Inspection: _____ Semi-Annual Staff _____ 90 Day Interim

River Basin: _____ **Date of Inspection** _____

Feature	Sat	Unsat	Deficiencies
PUMPING STATIONS - STRUCTURES			
INTERIOR			
EXTERIOR			
PUMPS - MOTORS - ENGINES			
TRIAL OPERATED			
GENERAL CONDITION			
POWER SOURCE			
INSULATION TESTS			
METAL INTAKES/OUTLETS			
GATE VALVES			
GATES - DRAINAGE STRUCTURES			
TRIAL OPERATED			
GENERAL CONDITION			
LUBRICATION			
DIKES - DAMS			
GENERAL CONDITION			
SLOPES/EROSION			
SAND BOILS/CAVING			
TRESPASSING			
SLOPE PROTECTION			
DRAINS			
STOP-LOGS - LOG BOOM			
CONDITION OF LOGS			
AVAILABILITY OF LOGS			
HIGHWAY SLOTS			
STORAGE FACILITIES			
CHANNELS - OUTLET WORKS CHANNEL			
BANKS			
OBSTRUCTION CONTROL			

INSPECTION REPORT - CHECK LIST
FLOOD PROTECTION SYSTEM, NEW HAVEN, CT

Use with NED Form 513 - Inspection Report:

I. Flood Wall

Date _____

a. Alignment;

Top

Sides

Ends

b. Movement

Tilt

Rotation

c. Joints

Open/Closed

Cracked

d. Surfaces

Cracked

Spalled

e. Settlement, Uplift

f. Seepage

Wet Areas

Boils

g. Cracks, Scouring, Undermining

h. Bank Caving

i. Animal Holes, Tree Stumps, Roots

j. Debris, Obstructions

k. Slope Covering, Rock/Grass

l. Toe Drains

m. Miscellaneous Comments

II. Dikes

- a. Lines, grades, section top _____
- b. Movement & Alignment _____
- c. Seepage
Boils _____
Saturated Areas _____
- d. Cracks, Settlement, Slumps,
Holes, Slides _____
- e. Slope Covering Rock _____
- f. Wave-Wash _____
- g. Flow Obstructions
Weeds/Brush _____
- h. Debris, Siltation _____
- i. Trespass _____
- j. Miscellaneous _____

III. Diesel Engine Powered Portable Pumps

- a. Pumps
 - 1. Trial Operated _____
 - 2. Lubrication _____
 - 3. Suction hose _____
 - 4. Discharge hose _____
 - 5. General Condition _____
- b. Pump Engines
 - 1. Trial Operated _____
 - 2. Starting System _____
 - 3. Exhaust System _____
- d. Instrumentation _____

IV. Miscellaneous

- a. Is emergency operation plan up-to-date? _____
- b. Is sufficient emergency equipment available at all times? _____
- c. Is sufficient manpower available at all times? _____
- d. Is the emergency equipment in good working condition? _____
- e. Has the semi-annual report been submitted? _____

V. General

- a. Have all deficiencies noted in previous Inspection Report been corrected? _____
- b. Has any high water been experienced since the last Inspection Report? _____

If so, describe briefly, including dates, height of water, and effect on protective works. _____

VI. Remarks and Additional Comments

Indicate observations, discussions, specific feature deficiencies, recommendations and any other pertinent information. Use continuation sheet if necessary.

APPENDIX D
ASSURANCES OF LOCAL COOPERATION

LOCAL COOPERATION AGREEMENT
BETWEEN
THE DEPARTMENT OF THE ARMY
AND
THE STATE OF CONNECTICUT
FOR CONSTRUCTION OF THE
WEST RIVER LOCAL PROTECTION PROJECT
NEW HAVEN, CONNECTICUT

THIS AGREEMENT entered into this 17th day of January, 1989, by and between the DEPARTMENT OF THE ARMY (hereinafter referred to as "Government"), acting by and through the Commander, U.S. Army Engineer Division, New England and the STATE OF CONNECTICUT (hereinafter referred to as "Local Sponsor"), acting by and through Department of Environmental Protection, Pursuant to Connecticut General Statutes, Section 25-76.

WITNESSETH THAT:

WHEREAS, the authority for the construction of the West River Local Protection Project at New Haven, Connecticut (hereinafter referred to as the "project") not specifically authorized by Congress is contained in Section 205 of the Flood Control Act of 1948, as amended, 33 U.S.C. 701s; and

WHEREAS, Section 205 of the Flood Control Act of 1948, as amended, 33 U.S.C. 701s, limits Federal expenditures for a project at any single locality to \$5,000,000.00; and

WHEREAS, construction of the project is described in a report entitled Detailed Project Report/Environmental Assessment West River, New Haven, Connecticut prepared by the Division Engineer, U.S. Army Engineer Division, New England, dated July 1985 and approved by the Chief of Engineers on January 13, 1986;

WHEREAS, Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, specified the cost-sharing requirements applicable to the project; and

WHEREAS, the local sponsor has the authority and capability to furnish the cooperation as set forth in Section 25-76 of the Connecticut General Statutes and is willing to participate in project cost-sharing and financing in accordance with the terms of this Agreement;

NOW, THEREFORE, the parties agree as follows:

ARTICLE I - DEFINITIONS

For purposes of this Agreement:

a. The term "project" shall mean construction of walls, dikes and channel modifications along sections of the West River and Wintergreen Brook.

b. The term "total project costs" shall mean all costs incurred by the Local Sponsor and the Government directly related to construction of the project. Such costs shall include, but not necessarily be limited to, actual construction costs, costs of preparation of contract plans and specifications, costs of applicable engineering and design, supervision and administration costs, costs of project construction contract dispute settlements or awards, and the value of lands, easements, rights-of-way, relocations, and alteration costs provided for the project by the local sponsor, but shall not include any costs for betterments or operation and maintenance, nor Government costs for preauthorization studies.

c. The term "period of construction" shall mean the time from the advertisement of the first construction contract to the time of acceptance of the project by the Contracting Officer.

d. The term "Contracting Officer" shall mean the Commander of the U.S. Army Engineer, New England Division, or his designee.

e. The term "highway" shall mean any highway, thoroughfare, roadway, street, or other public or private road or way.

f. The term "days" shall mean successive twenty-four-hour days, including non-working days such as Saturdays, Sundays and holidays, unless otherwise specifically indicated.

g. The term "fiscal year" shall mean one fiscal year of the United States Government, unless otherwise specifically indicated. The Government fiscal year begins on October 1 and ends on September 30.

ARTICLE II - OBLIGATIONS OF PARTIES

a. The Government, subject to and using funds provided by the local sponsor and appropriated by the Congress, shall expeditiously construct the project (including alterations or relocations of railroad bridges and approaches thereto), applying those procedures usually followed or applied in Federal projects, pursuant to Federal laws, regulations, and policies. The local sponsor shall be afforded the opportunity to review and comment on all contracts, including relevant plans and specifications, prior to the issuance of invitations for bids. The local sponsor also shall be afforded the opportunity to review and comment on all modifications and change orders prior to the issuance to the contractor of a Notice to Proceed. The Government will consider the views of the local sponsor, but award of the contracts and performance of the work thereunder shall be exclusively within the control of the Government.

b. When the Government determines that the project, or functional element thereof, is complete, the Government shall turn the completed element or project over to the local sponsor, which shall accept the project or element and be solely responsible for operating, maintaining, replacing, and rehabilitating the project or element in accordance with Article VIII hereof.

c. As further specified in Article VI hereof, the local sponsor shall provide, during the period of construction, a cash contribution of 5 percent of total project costs.

d. As further specified in Article III hereof, the local sponsor shall provide all lands, easements, rights-of-way, and perform all relocations and alterations of buildings, utilities (other than those portions which pass under or through the project's structures), highways, bridges (other than railroad bridges and approaches thereto), sewers, and related and special facilities determined by the Government to be necessary for construction of the project.

e. If the value of the contributions provided under paragraphs c. and d. of this Article represents less than 25 percent of the project cost associated with flood control, the local sponsor shall provide during the period of construction an additional cash contribution in the amount necessary to make its total contribution for flood control equal to 25 percent of the total project costs for that purpose.

f. The local sponsor shall pay all costs in excess of the Federal statutory cost limitation of \$5,000,000. In no instance shall the Government's share of project costs, including preauthorization planning costs (reconnaissance studies, feasibility studies, etc), exceed this limitation.

g. With respect to areas protected from floods by the project, the Local Sponsor shall participate in and comply with the applicable Federal flood plain management and flood insurance programs.

h. No less than once each year the local sponsor shall inform affected interests of the limitations of the protection afforded by the Project.

i. The local sponsor shall publicize flood plain information in the area concerned and shall provide this information to zoning and other regulatory agencies for their guidance and leadership in preventing unwise future development in the flood plain and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the project.

j. The local sponsor shall, to the extent of its powers, prescribe and enforce regulations to prevent obstruction of or encroachment on the project that would reduce the level of protection it affords or that would hinder operation and maintenance.

k. The local sponsor will in addition to other payments provided herein, pay 50% of the total project costs assigned to recreation features of the Project.

ARTICLE III - LANDS, FACILITIES, AND RELOCATION ASSISTANCE

a. Prior to the advertisement of any construction contract, the local sponsor shall furnish to the Government all lands, easements, and rights-of-way, as may be determined by the Government to be necessary for construction of the

project, and shall furnish to the Government evidence supporting the local sponsor's legal authority to grant rights-of-entry to such lands.

b. The local sponsor shall provide or pay to the Government the full cost of providing all retaining dikes, wasteweirs, bulkheads, and embankments, including all monitoring features and stilling basins, that may be required at any dredged material disposal areas necessary for construction of the project.

c. Upon notification from the Government, the local sponsor shall accomplish or arrange for accomplishment at no cost to the Government all alterations and relocations of buildings, highways, bridges (other than railroad bridges and approaches thereto), storm drains, utilities (other than those portions which pass under or through the project's structure), cemeteries and other facilities, structures, and improvements determined by the Government to be necessary for construction of the project.

d. The local sponsor shall comply with the applicable provisions of the Uniform Relocations Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended, in acquiring lands, easements and rights-of-way for construction and subsequent operation and maintenance of the Project and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

ARTICLE IV - VALUE OF LANDS AND FACILITIES

a. The value of the lands, easements, and rights-of-way to be included in total project costs and credited toward the local sponsor's share of total project costs will be determined in accordance with the following procedures:

1. If the lands, easements, or rights-of-way are owned by the local sponsor as of the date this Agreement is signed, the credit shall be the fair market value of the interest at the time such interest is made available to the Government for construction of the project. The fair market value shall be determined by an appraisal, to be obtained by the local sponsor, which has been prepared by an independent and qualified appraiser who is acceptable to both the local sponsor and the Government. The appraisal shall be reviewed and approved by the Government.

2. If the lands, easements, or rights-of-way are to be acquired by the local sponsor after the date this Agreement is signed, the credit shall be the fair market value of the interest at the time such interest is made available to the Government for construction of the project. The fair market value shall be determined as specified in subparagraph 1. above. If the local sponsor pays an amount in excess of the appraised fair market value, it may be entitled to a credit for the excess if the local sponsor has secured prior written approval from the Government of its offer to purchase such interest.

3. If the local sponsor acquires more lands, easements, or rights-of-way than are necessary for project purposes, as determined by the Government, than only the value of such portions of those acquisitions as are necessary for project purposes shall be included in total project costs and credited to the sponsor's share.

4. Credit for lands, easements, and rights-of-way in the case of involuntary acquisitions which occur within a one-year period preceding the date this Agreement is signed or which occur after the date this Agreement is signed will be based on court awards, or on stipulated settlements that have received prior Government approval.

5. For lands, easements, or rights-of-way acquired by the local sponsor within a five-year period preceding the date this Agreement is signed, or any time after this agreement is signed, credits provided under this paragraph will also include the actual incidental costs of acquiring the interest, e.g... closing and title costs, appraisal costs, survey costs, attorney's fees, plat maps, and mapping costs, as well as the actual amounts expended for any relocation assistance provided in accordance with the obligations under this Agreement.

b. The costs of relocations or modifications of utilities (other than those portions which pass under or through the projects's structure), or facilities that will be included in total project costs and credited towards the sponsor's share of total project costs shall be that portion of the actual costs incurred by the local sponsor as set forth below:

1. Highways and highways bridges: Only that portion of the cost as would be necessary to construct substitute bridges and highways to the design standard that the State of Connecticut would use in constructing a new bridge or highway under similar conditions of geography and traffic loads.

2. Utility and Facilities (including railroads): Actual relocation costs, less depreciation, less salvage value, plus the cost of removal, less the cost of betterments. With respect to betterments, new materials shall not be used in any relocation or alteration if materials of value and usability equal to those in the existing facility are available or can be obtained as salvage from the existing facility or otherwise, unless the provision of new material is more economical. If despite the availability of used material, new material is used, where the use of such new material represents an additional cost, such cost shall not be included in total project costs.

ARTICLE V - CONSTRUCTION PHASING AND MANAGEMENT

a. To provide for consistent and effective communication between the local sponsor and the Government during the term of construction, the local sponsor and the Government shall appoint representatives to coordinate on scheduling, plans, specifications, modifications, contract costs, and other matters relating to construction of the project.

b. The representatives appointed above shall meet as necessary during the term of project construction and shall make such recommendations as they deem warranted to the Contracting Officer.

c. The Contracting Officer shall consider the recommendations of said representatives in all matters relating to the project, but the Contracting Officer, having ultimate responsibility for construction of the project, has complete discretion to accept, reject, or modify the recommendations.

ARTICLE VI - METHOD OF PAYMENT

a. The local sponsor shall provide, over the term of construction, the amounts required under Article II.c., II.e. II.f. and II.k. of this Agreement. Total project costs are presently estimated to be \$6,100,000. In order to meet its share, the local sponsor must provide a total cash contribution presently estimated to be \$431,000 consisting of \$291,000 for Article II (c) and \$140,000 for Article II (k).

b. The local sponsor shall provide its required cash contribution in proportion to the rate of Federal expenditures over the term of the construction period in accordance with the following provisions:

1. For purposes of budget planning, the Government shall notify the local sponsor by September of each year of the estimated funds that will be required from the local sponsor to meet its share of project costs for the corresponding Government fiscal year.

2. No later than 30 days prior to the award of the first construction contract, the Government shall notify the local sponsor of its share of project costs, including costs attributable to the project incurred prior to the initiation of construction, for the first fiscal year of construction. No later than 15 days thereafter, the local sponsor shall provide the requisite amount to the Government in cash by delivering a check payable to "FAO, USAED, New England Division" to the Contracting Officer, or verify to the satisfaction of the Government that it has deposited the requisite amount in an escrow account acceptable to the Government, with interest accruing to the local sponsor, or present to the Government an irrevocable letter of credit acceptable to the Government in an amount sufficient to meet its obligations.

3. For the second and subsequent fiscal years of project construction, the Government shall, 60 days prior to the beginning of the fiscal year, notify the local sponsor of its share of project costs for that fiscal year. No later than 30 days prior to the beginning of the fiscal year, the local sponsor shall make the necessary funds available to the Government through the funding mechanism specified above. As construction of the project proceeds, the Government may adjust the amounts required to be provided under this paragraph to reflect actual project costs.

4. If at any time during the period of construction the Government determines that additional funds will be needed from the local sponsor to meet its required share of project costs, the Government shall so notify the local sponsor and the local sponsor, no later than 30 days from receipt of notice, shall make the necessary funds available through the funding mechanism specified above.

c. The Government will draw on the funds, or escrow account, or letter of credit provided by the local sponsor such sums as it deems necessary to cover contractual and in-house fiscal obligations attributable to the project as they are incurred, as well as project costs incurred by the Government prior to initiation of construction.

d. Upon completion of the project and resolution of all relevant contract claims and appeals, the Government shall compute the total project costs and tender to the local sponsor a final accounting of its share of project costs. In the event the total contribution by the local sponsor is less than its required share of total project costs, the local sponsor shall within 90 calendar days after receipt of written notice, make a cash payment to the Government of whatever sum is required to meet its minimum required share of total project costs.

e. In the event the local sponsor has made cash contributions in excess of 5 percent of total project costs which result in the local sponsor's having provided more than its required share of project costs, the Government shall within 90 days of the final accounting, subject to the availability of appropriations and subject to the Federal statutory cost limitation set out in Article II.f., return said excess to the local sponsor; however, the local sponsor shall not be entitled to any refund of the 5 percent cash contribution required pursuant to Article II.c. hereof.

f. If the local sponsor's total contribution under this Agreement (including lands, easements, rights-of-way and relocations provided by the local sponsor) exceeds 50 percent of total project costs, the Government shall, subject to the availability of appropriations for that purpose, and subject to the Federal statutory cost limitation set out in Article II.f., refund the excess to the local sponsor no later than 90 days after the final accounting is complete.

ARTICLE VII - DISPUTES

Before any party to this Agreement may bring suit in any court concerning an issue relating to this Agreement, such party must first seek in good faith to resolve the issue through negotiation or other forms of non-binding alternate dispute resolution mutually acceptable to the parties.

ARTICLE VIII - OPERATION, MAINTENANCE AND REHABILITATION

a. After it is turned over by the Government, The local sponsor shall operate, maintain, replace, and rehabilitate the project or functional element thereof in accordance with regulations or directions prescribed by the Government.

b. The local sponsor hereby gives the Government a right to enter, at reasonable times and in a reasonable manner, upon land which it owns or controls for the project for the purpose of inspection, and, if necessary, for

the purpose of completing, operating, repairing, maintaining, replacing, or rehabilitating the project. If an inspection shows that the local sponsor for any reason is failing to fulfill its obligations under this Agreement without receiving prior written approval from the Government, the Government will send a written notice to the local sponsor. If the local sponsor persists in such failure for 30 calendar days after receipt of the notice, then the Government shall have a right to enter, at reasonable times and in a reasonable manner, upon lands the local sponsor owns or controls for the project for the purpose of completing, operating, repairing, maintaining, replacing, or rehabilitating the project. No completion, operation, repair, maintenance, replacement, or rehabilitation by the Government shall operate to relieve the local sponsor of responsibility to meet its obligations as set forth in this Agreement, or to preclude the Government from pursuing any other remedy at law or equity to assure faithful performance pursuant to this Agreement.

ARTICLE IX - RELEASE OF CLAIMS

The local sponsor shall hold and save the Government free from all damages arising from the construction, operation and maintenance of the project, except for damages due to the fault or negligence of the Government or its contractors.

ARTICLE X - MAINTENANCE OF RECORDS

The Government and the local sponsor shall keep books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to this Agreement to the extent and in such detail as will properly reflect total project costs. The Government and the local sponsor shall maintain such books, records, documents, and other evidence for a minimum of three years after completion of construction of the project and resolution of all claims arising therefrom, and shall make available at their offices at reasonable times, such books, records, documents, and other evidence for inspection and audit by authorized representatives of the parties to this Agreement.

ARTICLE XI - FEDERAL AND STATE LAWS

In acting under its rights and obligations hereunder, the local sponsor agrees to comply with all applicable Federal and State laws and regulations, including Section 601 of Title VI of the Civil Rights Act of 1964 (Public Law 88-

352) and Department of Defense Directive 5500.II issued pursuant thereto and published in Part 300 of Title 32, Code of Federal Regulations, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army."

ARTICLE XII - RELATIONSHIP OF PARTIES

The parties to this Agreement act in an independent capacity in the performance of their respective functions under this Agreement, and neither party is to be considered the officer, agent, or employee of the other.

ARTICLE XIII - OFFICIALS NOT TO BENEFIT

No member of or delegate to the Congress, or resident commissioner, shall be admitted to any share or part of this Agreement, or to any benefit that may arise therefrom.

ARTICLE XIV - COVENANT AGAINST CONTINGENT FEES

The local sponsor warrants that no person or selling agency has been employed or retained to solicit or secure this Agreement upon agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by the local sponsor for the purpose of securing business. For breach or violation of this warranty, the Government shall have the right to annul this Agreement without liability, or, in its discretion, to add to the Agreement or consideration, or otherwise recover, the full amount of such commission, percentage, brokerage, or contingent fee.

ARTICLE XV - TERMINATION OR SUSPENSION

a. If at any time the local sponsor fails to make the payments required under this Agreement, the Secretary of the Army shall terminate or suspend work on the project until the local sponsor is no longer in arrears or unless the Secretary determines that continuation of work on the project is in the interest of the United States. Any delinquent payment shall be charged interest at a rate, to be determined by the Secretary of the Treasury, equal to 150 per centum of the average bond equivalent rate of the 13-week Treasury bills auctioned immediately prior to the date on which such payment became delinquent, or auctioned immediately prior to the beginning of each additional 3-month period if the period of delinquency exceeds 3 months.

b. If the Government fails to receive annual appropriations in amounts sufficient to meet expenditures for the then-current fiscal year, the Government shall so notify the local sponsor. After 60 days either party may elect without penalty to terminate the Agreement or to suspend performance thereunder, and the parties shall conclude their activities relating to the Project and proceed to a final accounting in accordance with Article VI.

ARTICLE XVI - OBLIGATION OF FUTURE APPROPRIATIONS

Nothing herein shall constitute, or be deemed to constitute, an obligation of future appropriations by the legislature of the State of Connecticut in accordance with Section 3-25 6b of the General Statutes of Connecticut.

ARTICLE XVII - NOTICES

a. All notices, requests, demands, and other communications required or permitted to be given under this Agreement shall be deemed to have been duly given if in writing and delivered personally, given by prepaid telegram, or mailed by first-class (postage-prepaid), registered, or certified mail, as follows:

If to the local sponsor:

Mr. Alphonse LeTendre
State of Connecticut
Department of Environmental Protection
165 Capitol Avenue, Hartford, CT 06106

If to the Government:

Division Engineer
Corps of Engineers, New England Division
424 Trapelo Road, Waltham, MA 02254-9149

b. A party may change the address to which such communications are to be directed by giving written notice to the other in the manner provided in this section.

c. Any notice, request, demand, or other communication made pursuant to this Article shall be deemed to have been received by the addressee at such time as it is personally delivered or on the third business day after it is mailed, as the case may be.

ARTICLE XVIII - CONFIDENTIALITY

To the extent permitted by the law governing each party, the parties agree to maintain the confidentiality of exchanged information when requested to do so by the providing party.

ARTICLE XIX - ABILITY TO PAY-NON-FEDERAL COST SHARE

A. The project does not qualify for a revision to the non-Federal cost share for flood control based on estimated flood control benefits and costs and on application of guidelines published as Flood Control Cost Sharing Requirements Under the Ability to Pay Provision; Interim Final Rule (Vol. 52 Federal Register pages 35872-35892, 1987 to be codified at (33 C.F.R., Sections 241.1-.6), implementing Section 103(m) of the Water Resources Development Act of 1986.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the day and year first above written.

STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL
PROTECTION

Witnesses:

Charles E. Buehler
Leonard W. Smith

By: Leslie Carothers
Leslie Carothers
Commissioner
Duly Authorized

Date: Jan. 17, 1989

THE DEPARTMENT OF THE ARMY

Witnesses:

Leonard W. Smith
Daniel M. Wilson

By: Daniel M. Wilson
DANIEL M. WILSON
Commander
U.S. Army Engineer
Division, New England
Duly Authorized

Date: 17 Jan 89

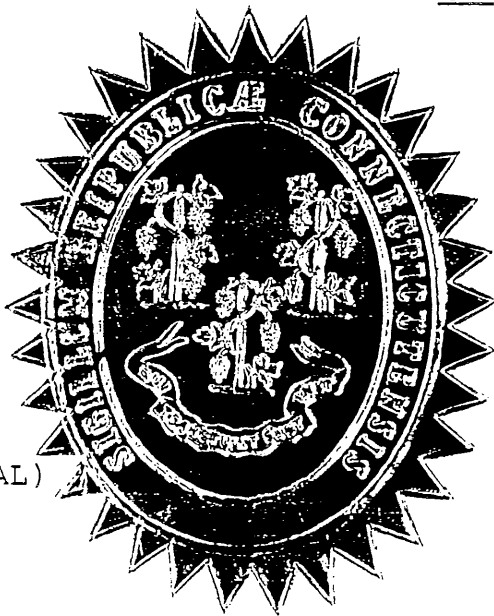
FUNDS AVAILABLE

3/3/89
DATE


CERTIFICATION OF AUTHORITY

I, Julia H. Tashjian, do hereby certify that I am the Secretary of the State of Connecticut named herein; that Leslie Carothers, who signed this Agreement on behalf of the State was there and then duly appointed and qualified Commissioner of the Department of Environmental Protection. I further certify that Clarine Nardi Riddle who approved the Agreement is Acting Attorney General for the State of Connecticut.

IN WITNESS WHEREOF, I have hereunto affixed my hand and seal of the State of Connecticut this 13th day of April 1987.



(SEAL)


Julia H. Tashjian
Secretary of State

CERTIFICATION

I, Clarine Nardi Riddle, certify that I am Acting Attorney General for the State of Connecticut, and that I have reviewed the agreement and that the Department of Environmental Protection is a legally constituted public agency with full authority and capability to perform the terms of the Agreement between the Department of the Army and the State of Connecticut in connection with the West River Local Protection Project in New Haven, Connecticut, and to pay damages, if necessary in the event of the failure to perform in accordance with Section 221 of Public Law 91-611 and that the persons who have executed the contract on behalf of the State of Connecticut have acted within their statutory authority.

IN WITNESS WHEREOF, I have made and executed this certificate this 6th day of April, 1987.


Clarine Nardi Riddle

Acting Attorney General

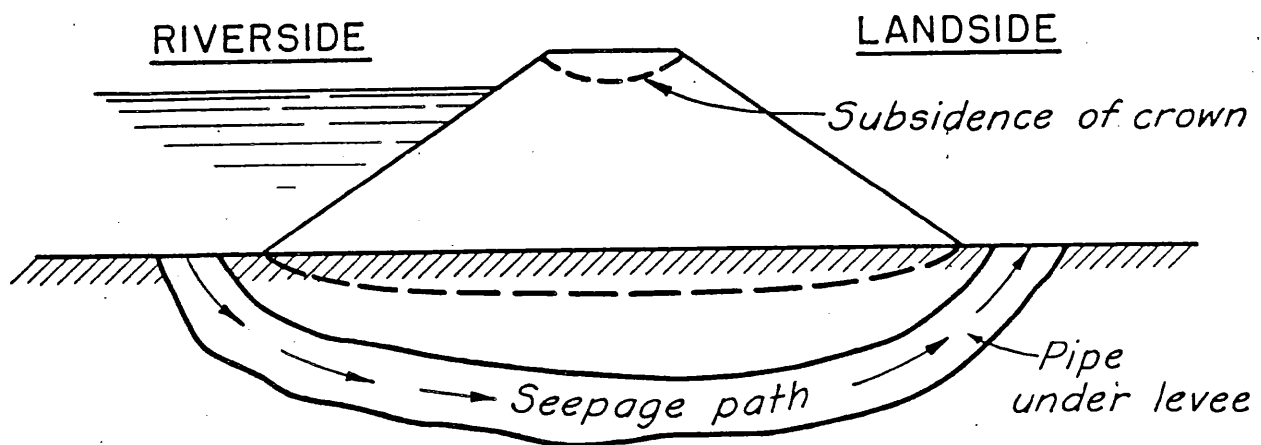
APPENDIX E
FLOOD EMERGENCY MEASURES

APPENDIX E
FLOOD EMERGENCY MEASURES

Table of Illustrations

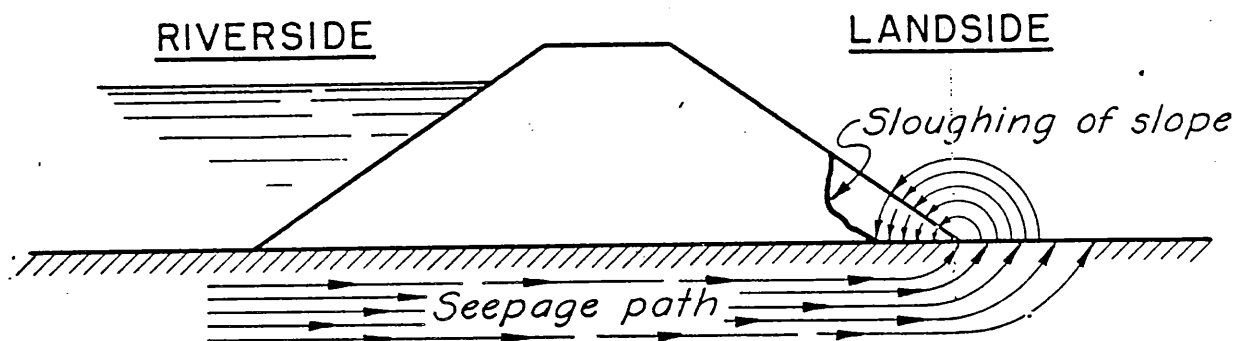
<u>Plate No.</u>	<u>Title</u>
E-I	Effect of Sand Boils
E-II	Sand Boil
E-III	Sacking Sloughs
E-IV	Sack Dike or Topping
E-V	Model Sack Dike or Topping

EFFECTS OF SAND BOILS ON LEVEE



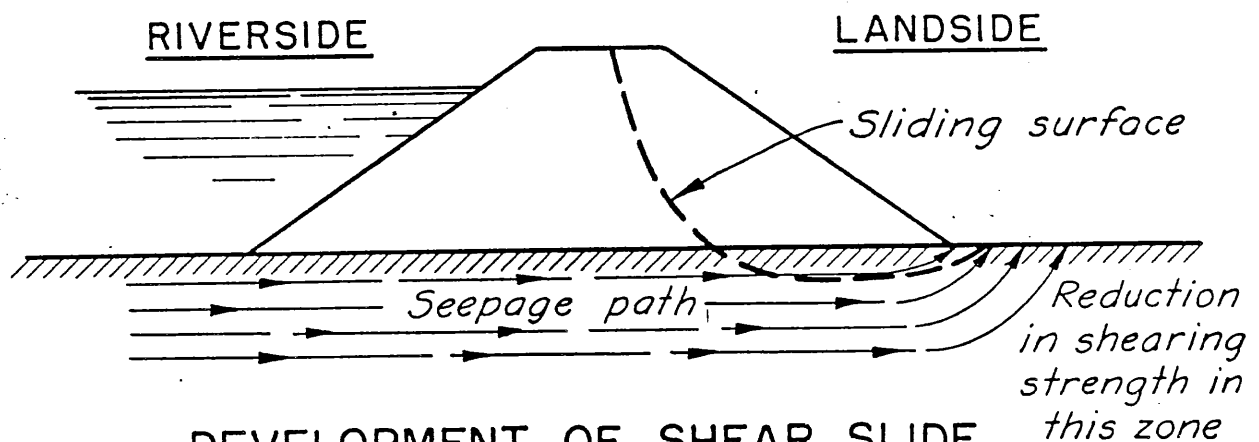
DEVELOPMENT OF PIPE UNDER LEVEE

Fig. 1



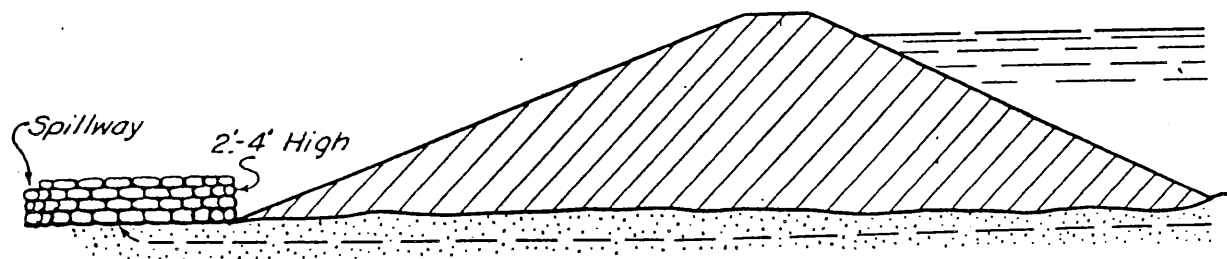
SLOUGHING OF LANDSLIDE SLOPE DUE TO RAVELLING AND UNDERCUTTING OF TOE

Fig. 2

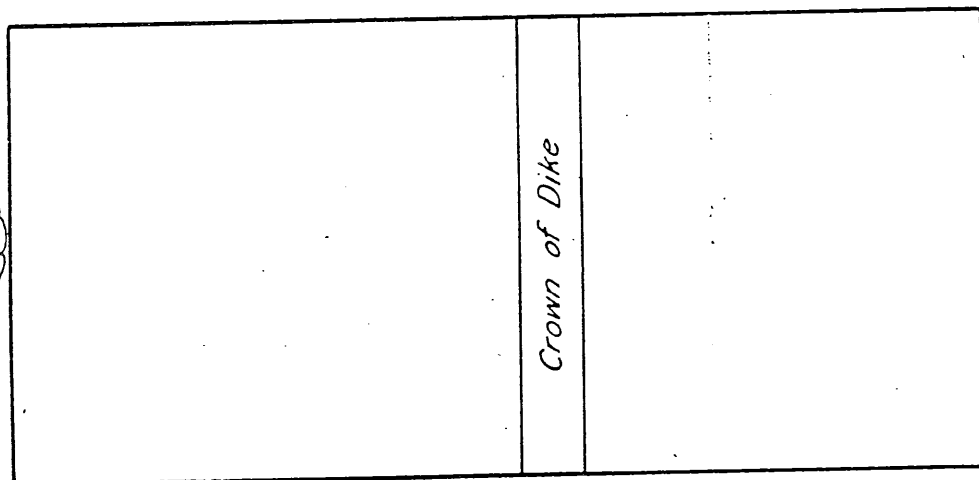
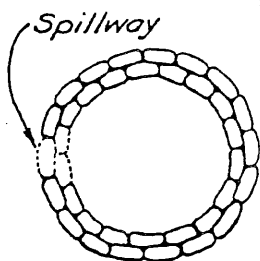


DEVELOPMENT OF SHEAR SLIDE

Fig. 3



Wall should be built on firm ELEVATION
 foundation, with width of base
 at least $1\frac{1}{2}$ times the height.
 Be sure to place sacks on ground
 clear of sand discharge.
 Tie into dike if boil is near toe.

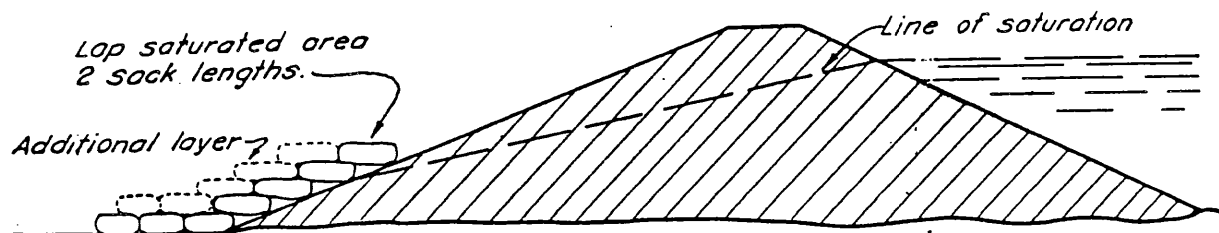


PLAN

Do not sack boil which
 does not put out material.
 Height of sack loop or ring
 should be only sufficient to
 create enough head to slow
 down flow through boil so
 that no more material is dis-
 placed and boil runs clear.
 Do not try to stop fully, flow
 through boil.

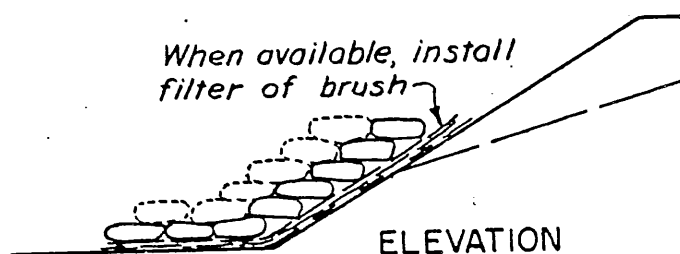
**SAND BOIL
 STANDARD HIGH WATER
 MAINTENANCE INSTRUCTION**

U. S. ENGINEER OFFICE,



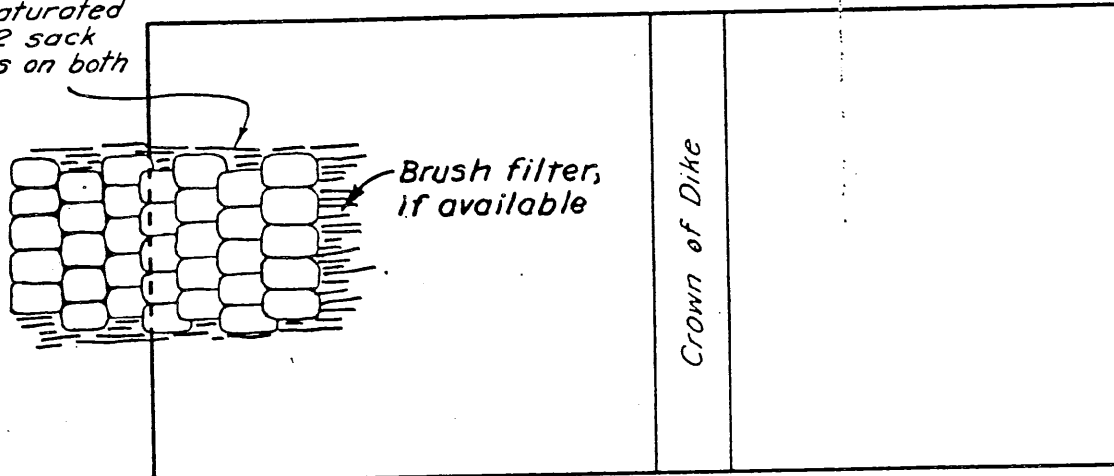
ELEVATION

Number of layers determined by velocity of seepage and amount of material being carried.



ELEVATION

Lap saturated area 2 sack widths on both ends.



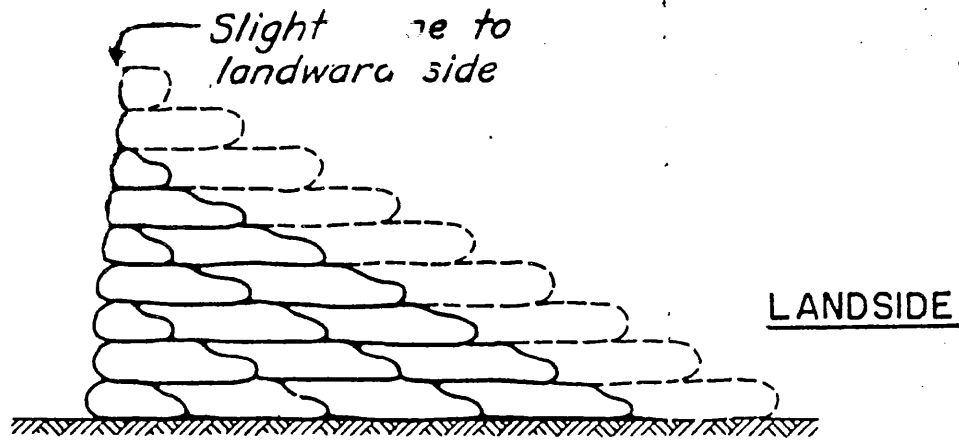
PLAN

Sacks should be laid shingle fashion and not mounded into place.

**SACKING SLOUGHS
STANDARD HIGH WATER
MAINTENANCE INSTRUCTION**

U. S. ENGINEER OFFICE,

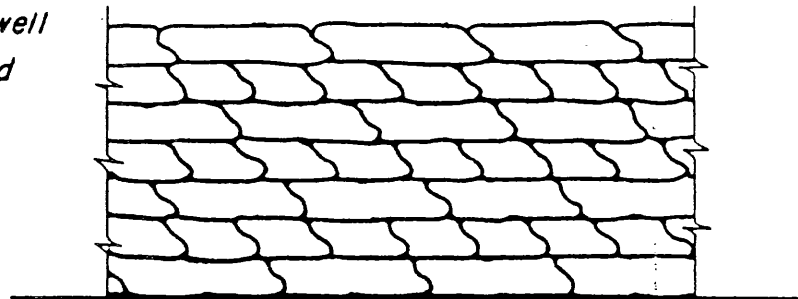
RIVERSIDE



LANDSIDE

SECTION

Note: Sacks should be lapped at least 1/3 all ways and well mauled or tamped into place.



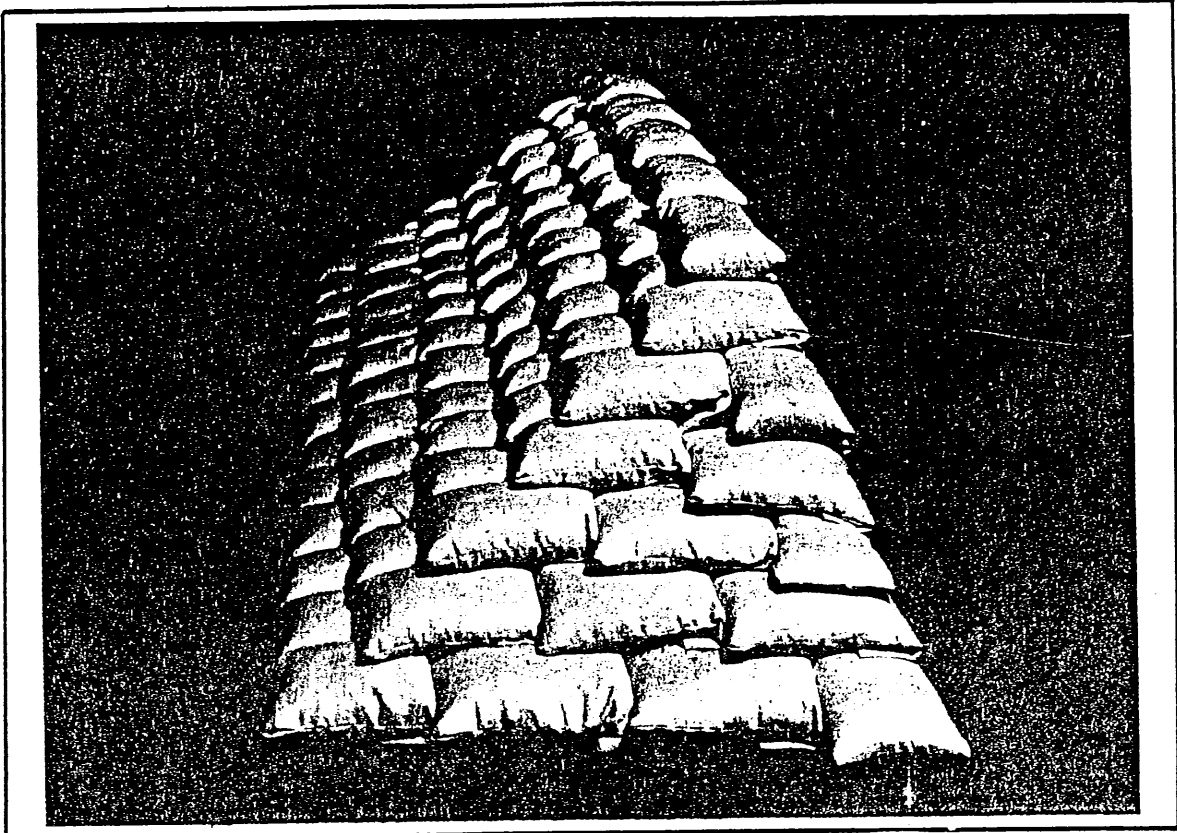
RIVERSIDE ELEVATION

SACKS REQUIRED PER 100' STA.
100 lb. "Feed" Sacks - 1 Cu. Ft. Each

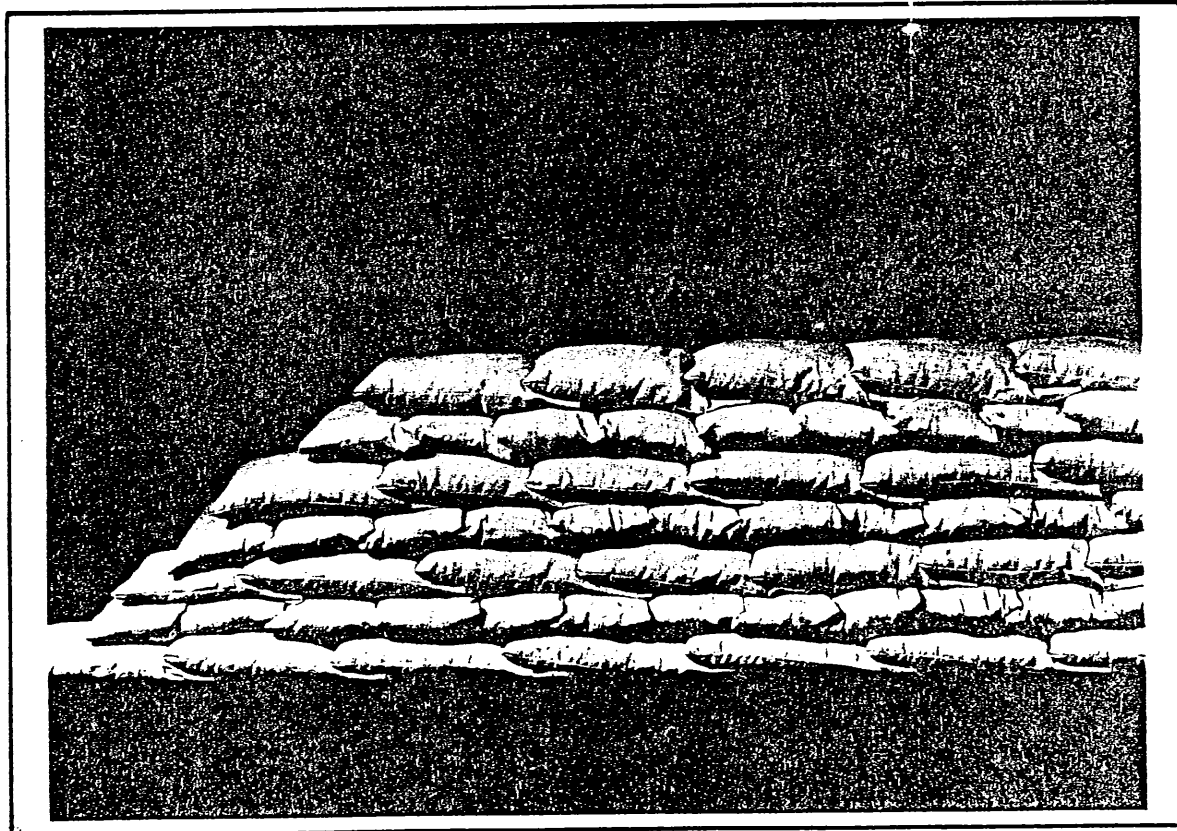
Approx. Hgt. Sack Dike	Sacks High	Required
1.5	3	300
2.0	4	750
3.0	6	1400
4.0	8	2250
5.0	10	3250
6.0	12	4500
7.0	14	5950
8.0	16	7600

SACK DIKE OR TOPPING
STANDARD HIGH WATER
MAINTENANCE INSTRUCTION

U. S. ENGINEER OFFICE,



MODEL SACK DIKE OR TOPPING
Typical Section



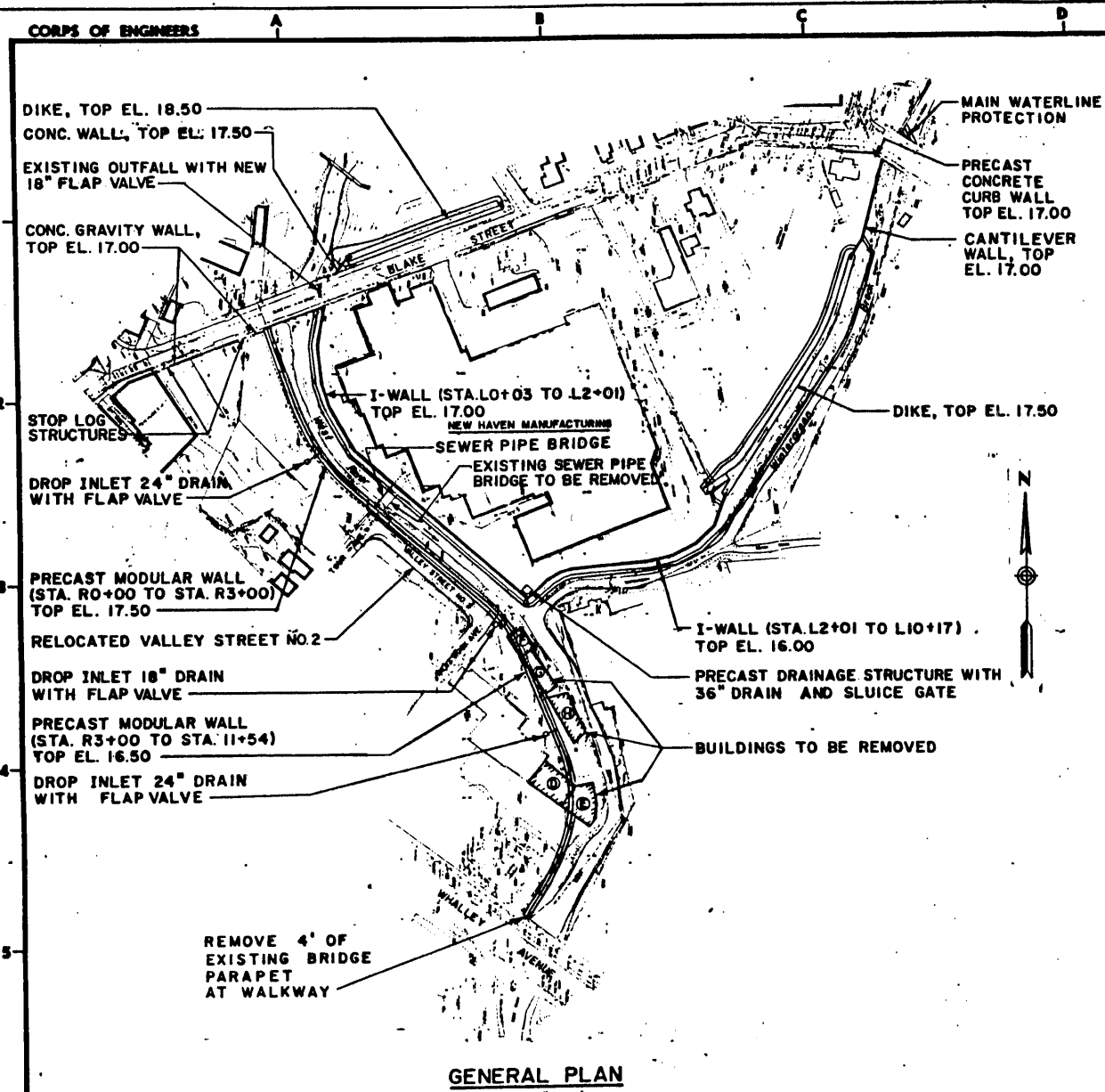
MODEL SACK DIKE OR TOPPING
Riverside View

APPENDIX F
PERTINENT "AS-BUILT" DRAWINGS

APPENDIX F
PERTINENT "AS-BUILT" DRAWINGS

Table of Illustrations

<u>Plate No.</u>	<u>Description</u>
1	General Plan and Index
2	Plan No. 1
3	Plan No. 2
4	Plan No. 3 and Details
5	Plan No. 4 and Details
6	Enlarged Plans and Sewer Profiles
7	General Drainage Plan and Profiles
8	Profile, Sections and Detail
9	River Cross Section No. 1 and Detail
10	River Cross Section No. 2 and Grade Control Structure
11	Drainage Structure and Details



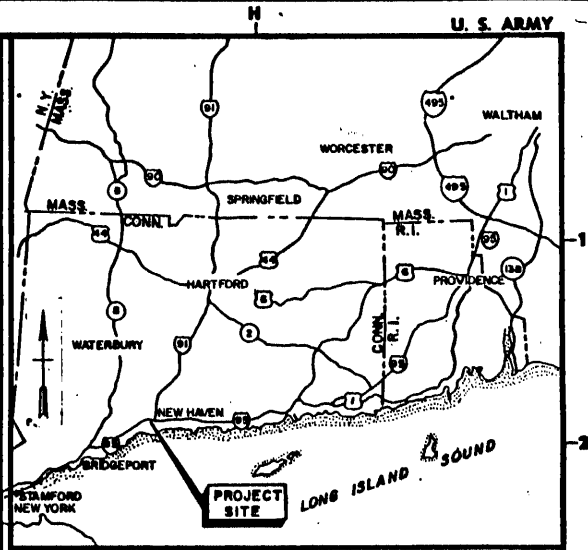
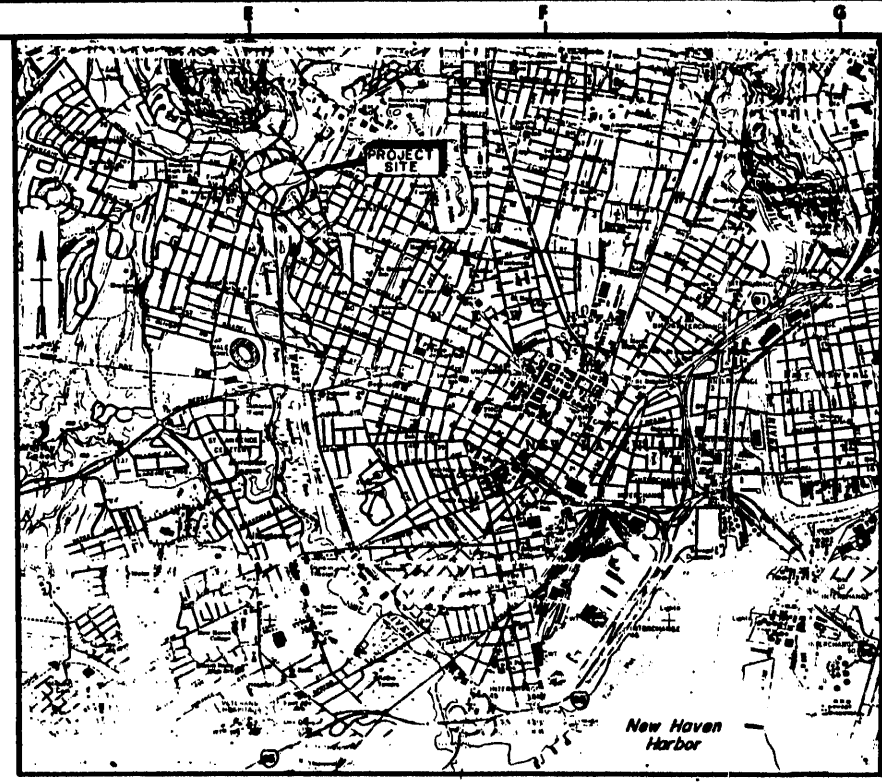
- GENERAL NOTES:**
- Elevations refer to National Geodetic Vertical Datum (N.G.V.D.) of 1929.
 - Coordinate system based on Connecticut Rectangular Coordinate System.
 - The limits of work for this contract are shown on Sheet 3 thru Sheet 6.
 - Boring locations are shown on Sheet 3 thru Sheet 6.
 - Clearing and grubbing of the wooded areas along the right and left banks of the West River and Wintergreen Brook, and along the alignment of the Blake Street Dike shall include removal of all trees and shrubs (standing or downed) to include all miscellaneous debris within the Contractor's Limit of Work. The wooded areas to be cleared & grubbed vary from small trees and shrubs to larger trees up to 4 feet in diameter. The contractor shall top all standing trees prior to felling.
 - Construction work will not be permitted in the channel or banks from 1 March to 1 July of each year.

SYMBOL LEGEND

USED WHEN SECTION OR DETAIL APPEARS ON SAME DRAWING ON WHICH SECTION OR DETAIL IS TAKEN.
SECTION OR DETAIL TITLE: DETAIL (A) OR SECTION (A)

USED WHEN SECTION OR DETAIL APPEARS ON A DIFFERENT DRAWING FROM THAT ON WHICH THE SECTION OR DETAIL IS TAKEN.
LETTER INDICATES DETAIL TITLE.
FIGURE INDICATES DRAWING ON WHICH DETAIL APPEARS.
SECTION OR DETAIL TITLE: DETAIL (A) OR SECTION (A)

FIGURE IN TITLE INDICATES REFERENCE TO DRAWING WHERE SECTION OR DETAIL IS TAKEN.



INDEX TO DRAWINGS

DRAWING NO./SH. NO.	TITLE
NHW - 1	GENERAL PLAN AND INDEX
2	CONTROL PLAN
2A	PHASING PLAN
2B	OMITTED
3	PLAN NO. 1
4	PLAN NO. 2
5	PLAN NO. 3 AND DETAILS
6	PLAN NO. 4 AND DETAILS
6A	ENLARGED PLANS AND SEWER PROFILES
7	PROFILES ALONG CONTROL LINES OF DIKES & WALLS
8	GENERAL DRAINAGE PLAN AND PROFILES
9	PROFILE, SECTIONS AND DETAIL
10	RIVER CROSS SECTION NO. 1 AND DETAIL
11	RIVER CROSS SECTION NO. 2 AND GRADE CONTROL STRUCTURE
12	MODULAR WALL ELEVATIONS, SECTION AND DETAILS
13	STRUCTURAL-ELEVATIONS, SECTIONS & DETAILS
14	DRAINAGE STRUCTURE AND DETAILS
15	I-WALL ELEVATION
16	I-WALL ELEVATION AND SECTIONS
17	I-WALL SECTIONS AND DETAILS
18	CANTILEVER WALL-PLAN, ELEVATION AND SECTIONS
19	STRUCTURAL-PLANS AND SECTIONS
20	MANHOLE, DROP INLET, FRAME AND COVER DETAILS
21	EROSION AND SEDIMENTATION-CONTROL PLAN AND DETAILS

LEGEND

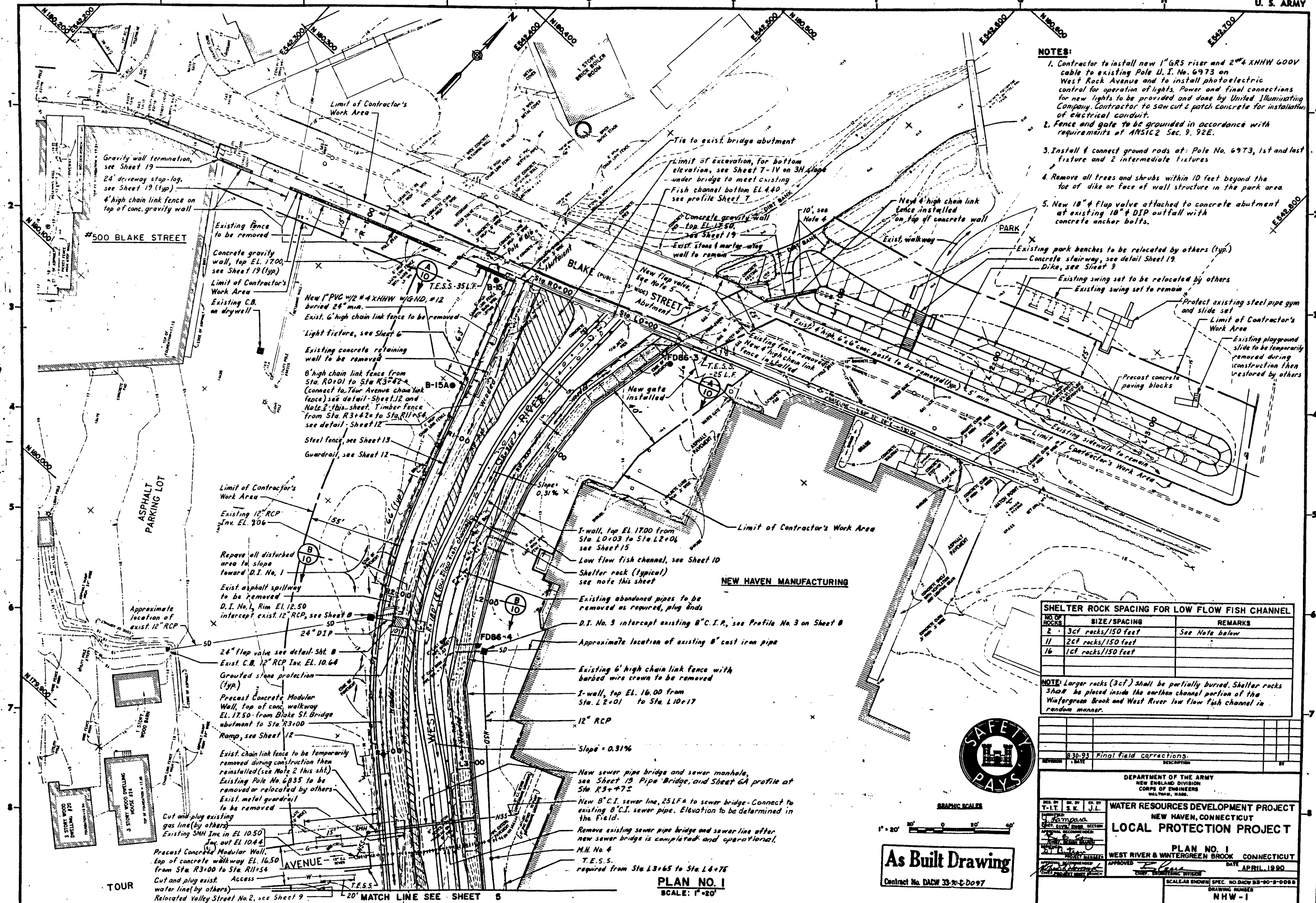
NEW	EXISTING	DESCRIPTION
— 12 —	— 12 —	CONTOURS
— 12 —	— 12 —	FENCE
— 12 —	— 12 —	ROAD OR WALK
— 12 —	— 12 —	BUILDING
— 12 —	— 12 —	GRADE TO DRAIN
— 12 —	— 12 —	LIMIT OF WORK
— 12 —	— 12 —	STONE PROTECTION
— 12 —	— 12 —	STORM DRAIN
— 12 —	— 12 —	SANITARY SEWER LINE
— 12 —	— 12 —	DRAIN INLET
— 12 —	— 12 —	DRAIN MANHOLE
— 12 —	— 12 —	SEWER MANHOLE
— 12 —	— 12 —	CATCH BASIN
— 12 —	— 12 —	GUARD RAIL
— 12 —	— 12 —	UNDERDRAIN
— 12 —	— 12 —	LIGHTING FIXTURE (QTY. 17)
— 12 —	— 12 —	SHRUBS
— 12 —	— 12 —	FIRE HYDRANT
— 12 —	— 12 —	GROUTED STONE PROTECTION
— 12 —	— 12 —	EARTH CUT SLOPE
— 12 —	— 12 —	BORING LOCATION & DESIGNATION
— 12 —	— 12 —	PIPE TO BE PLUGGED & REMOVED
— 12 —	— 12 —	EXCAVATE CHANNEL LIMIT
— 12 —	— 12 —	BUILDING TO BE DEMOLISHED & REMOVED
— 12 —	— 12 —	SPOT ELEVATION
— 12 —	— 12 —	POLE
— 12 —	— 12 —	OVERHEAD WIRE LINE
— 12 —	— 12 —	GAS LINE
— 12 —	— 12 —	WATER LINE
— 12 —	— 12 —	TEMPORARY EARTH SUPPORT SYSTEM
— 12 —	— 12 —	ELECTRICAL CONDUIT

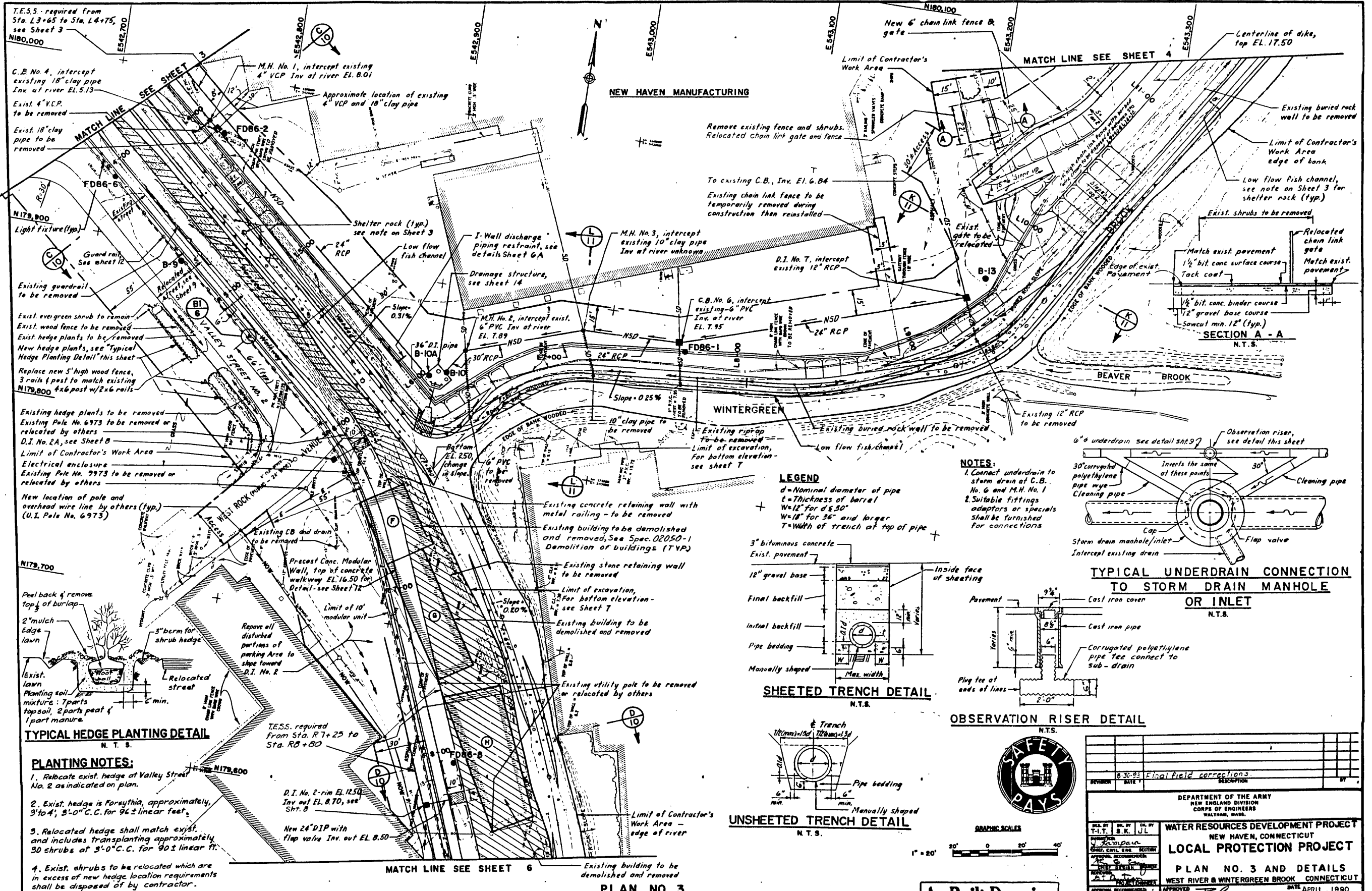


As Built Drawing
Contract No. DACW 33-90-C-0097

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

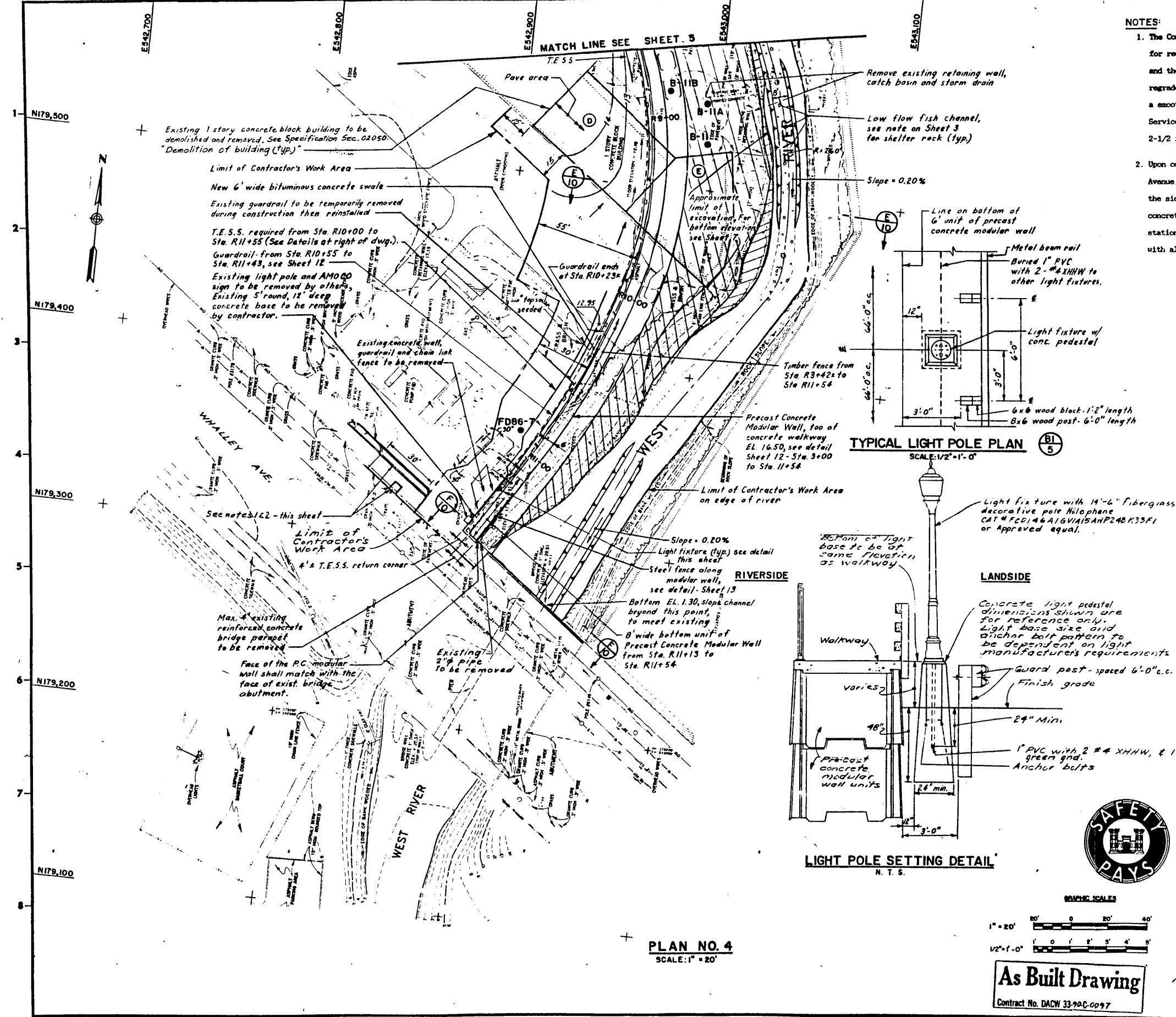
WATER RESOURCES DEVELOPMENT PROJECT
NEW HAVEN, CONNECTICUT
LOCAL PROTECTION PROJECT
GENERAL PLAN AND INDEX
WEST RIVER & WINTERGREEN BROOK, CONNECTICUT
APPROVED: [Signature] DATE: APRIL 1990
SCALE: AS SHOWN SPEC. NO. DACW 33-90-S-0086
DRAWING NUMBER: NHW - 1
SHEET 1



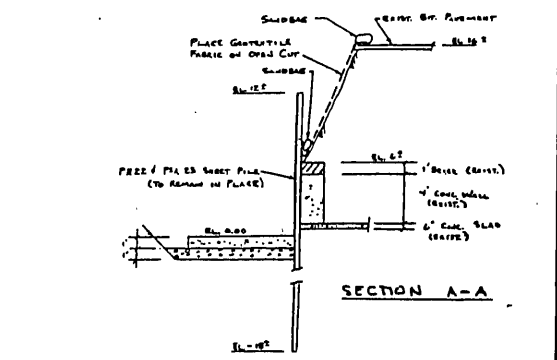
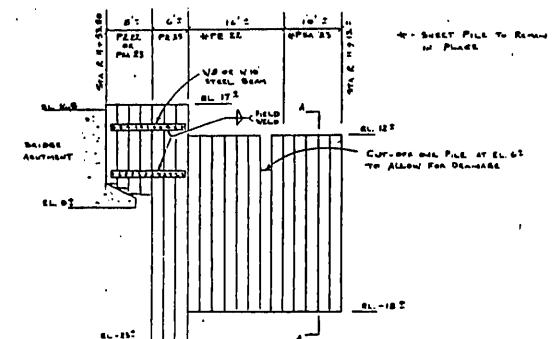


As Built Drawing
Contract No. DACW 33-90-C-0097

REVISION		DATE		DESCRIPTION	
1		8-30-93		Final field corrections	
DEPARTMENT OF THE ARMY NEW ENGLAND DIVISION CORPS OF ENGINEERS WALTHAM, MASS.					
WATER RESOURCES DEVELOPMENT PROJECT NEW HAVEN, CONNECTICUT LOCAL PROTECTION PROJECT PLAN NO. 3 AND DETAILS WEST RIVER & WINTERGREEN BROOK, CONNECTICUT DATE: APRIL, 1990					
DESIGNED BY: S.K. JL CHECKED BY: S.K. JL APPROVED BY: S.K. JL		DRAWING NUMBER: NHW-1 SHEET: 5			

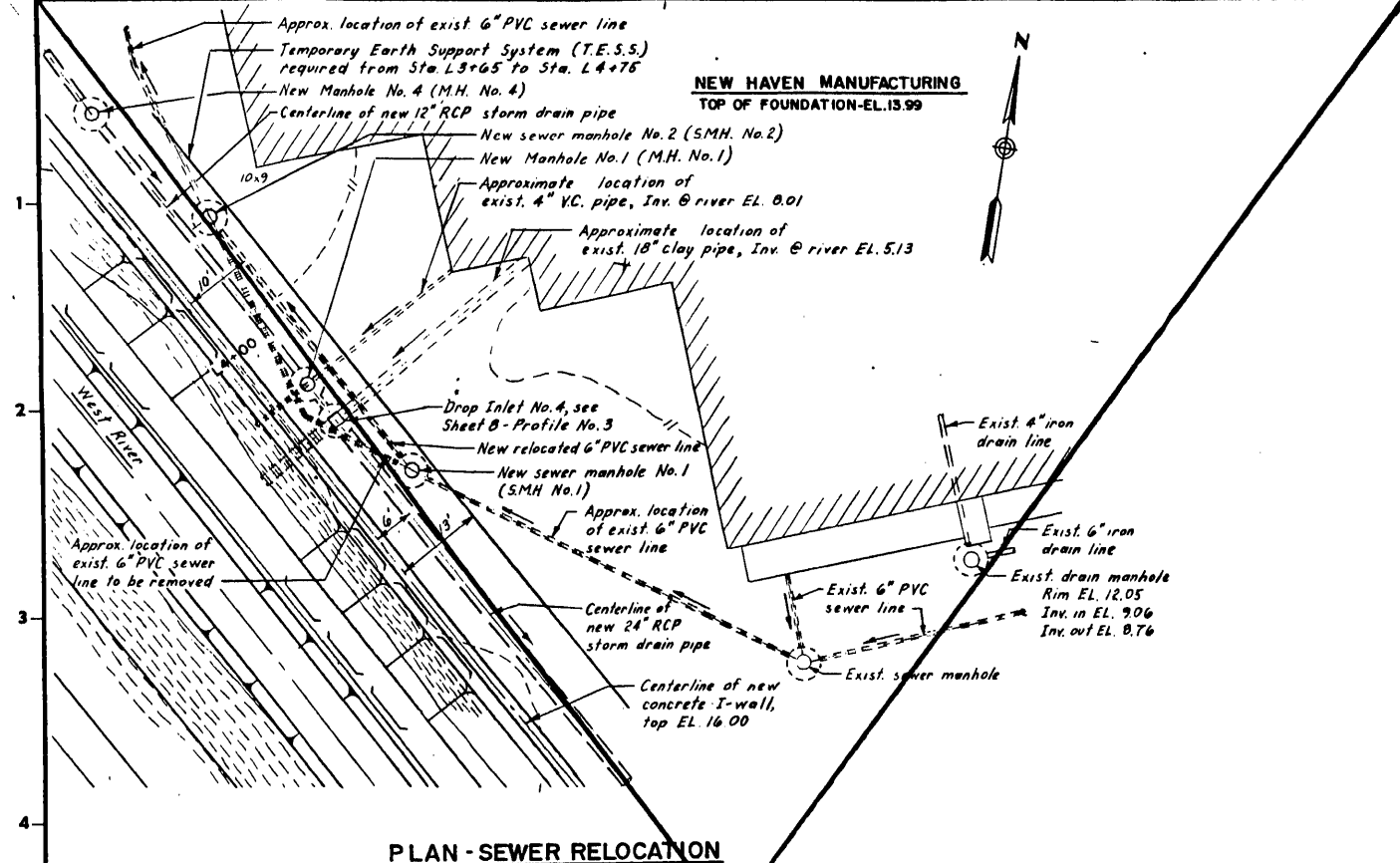


- NOTES:
1. The Contractor shall remove and store existing granite curb sections for reuse; remove and dispose of the existing concrete sidewalk sections and the existing concrete curb and median as indicated on the plan; and regrade and compact the existing sidewalk base course material to provide a smooth transition between the curb line of Whalley Avenue and the Amoco Service station. The temporary access shall be paved with a minimum of 2-1/2 inches of bituminous concrete binder course.
 2. Upon completion of the construction between station R10+00 and Whalley Avenue, the Contractor shall remove the temporary access and reconstruct the sidewalk, granite curbing (reusing the curbing removed and stored), the concrete curb and median, and the permanent access to the Amoco service station. Reconstruction of the permanent features shall be in accordance with all applicable construction standards of the City of New Haven, CT.



TEMPORARY EARTH SUPPORT SYSTEM
(R 11+53.8 TO R 11+13)

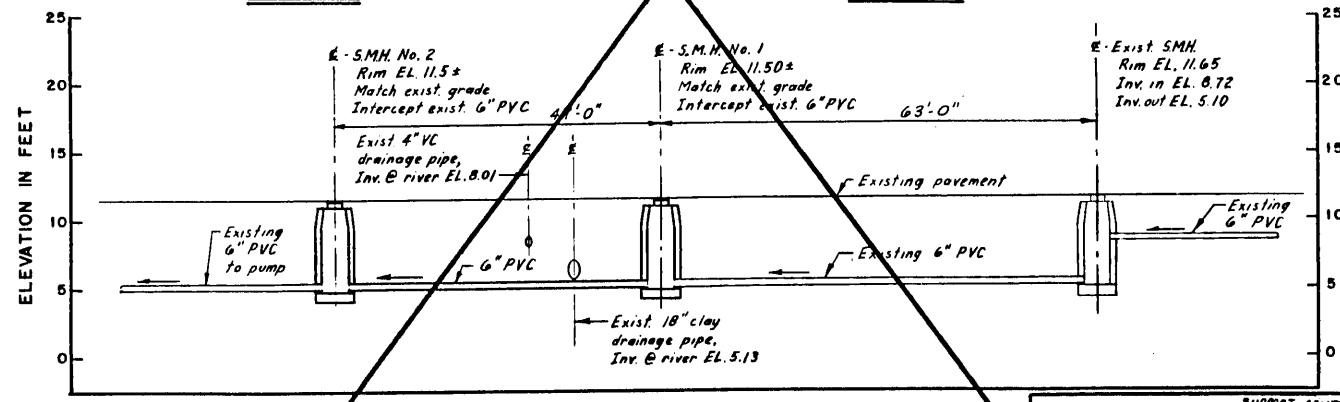
8-30-93 Final field corrections	
REVISION	DATE
DEPARTMENT OF THE ARMY NEW ENGLAND DIVISION CORPS OF ENGINEERS WALTHAM, MASS.	
WATER RESOURCES DEVELOPMENT PROJECT NEW HAVEN, CONNECTICUT	
LOCAL PROTECTION PROJECT PLAN NO. 4 AND DETAILS	
WEST RIVER & WINTERGREEN BROOK, CONNECTICUT	
APPROVED	DATE: APRIL, 1990
SCALE: AS SHOWN SPEC. NO. DACW 33-90-C-0098	
DRAWING NUMBER NHW-1	
SHEET 6	



PLAN - SEWER RELOCATION
SCALE: 1" = 10'

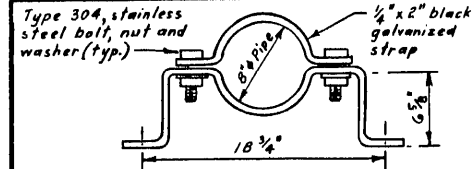
OMIT

OMIT

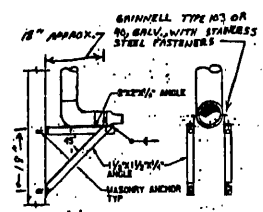


E - PROFILE OF EXISTING AND RELOCATED SEWER LINE
SCALE: Hori. 1" = 10', Vert. 1" = 8'

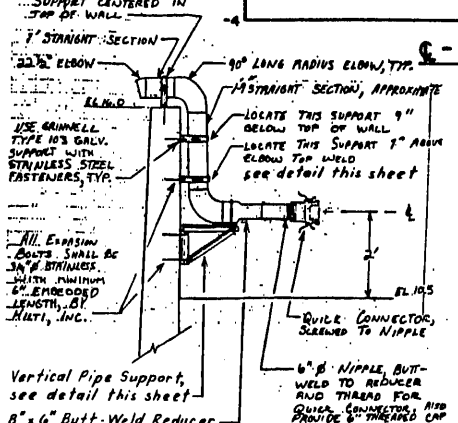
- NOTES:
- Existing 6" PVC invert at existing SMH. out EL. 5.10, slope unknown, profile on this sheet shows approximate elevation of existing and new sewer line, actual pipe inverts and location shall be verified in the field prior to construction.
 - 12" thick compacted gravel fill for foundation below on each Manhole.



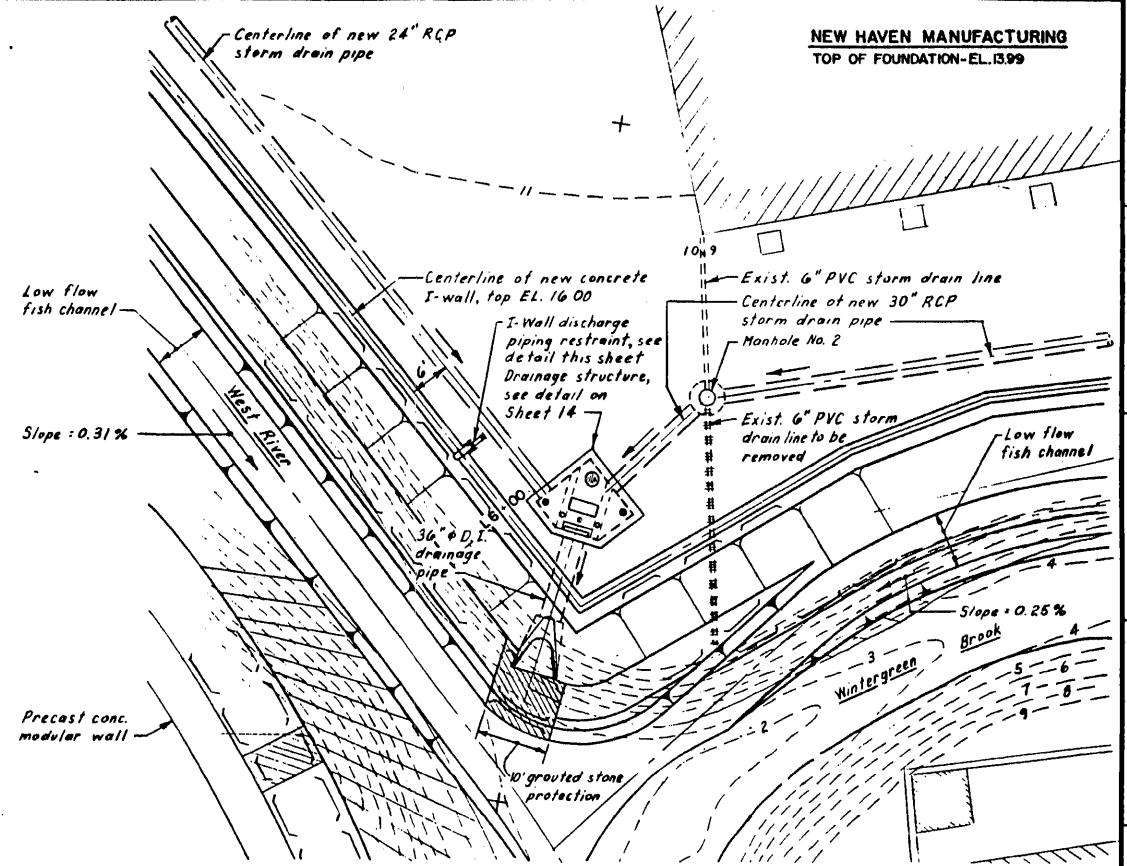
WALL SUPPORT DETAIL
N.T.S.



NOTES: SINGLE GRINNELL TYPE 103, 1/2" x 2" OR SUBSTITUTED IN LUE OF DUAL BRACKETS ABOVE
VERTICAL PIPE SUPPORT DETAIL
N.T.S.

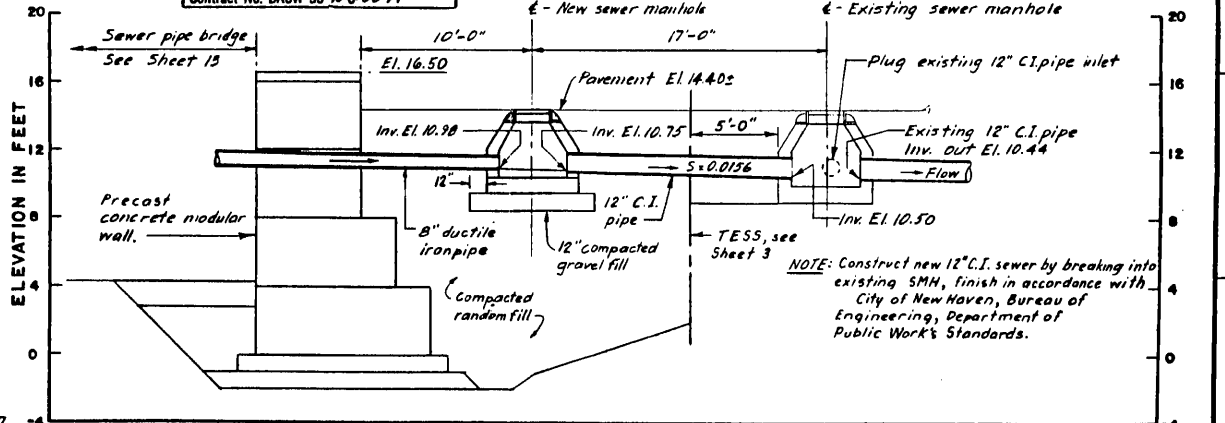


DISCHARGE PIPING DETAIL
N.T.S.

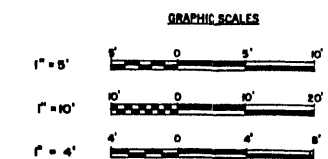


DRAINAGE STRUCTURE PLAN
SCALE: 1" = 10'

As Built Drawing
Contract No. DACW 33-90-C-0097



E - PROFILE OF RELOCATED SEWER LINE AT STA. R3+47±
SCALE: 1" = 4'



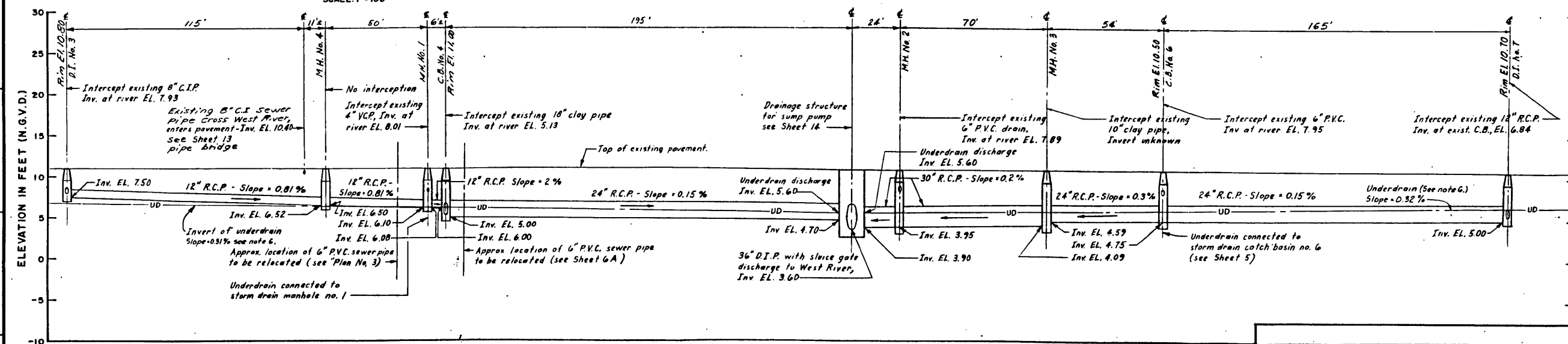
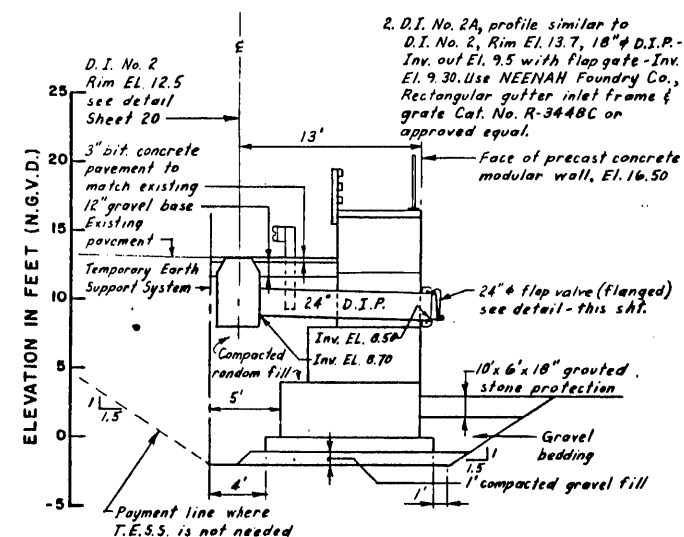
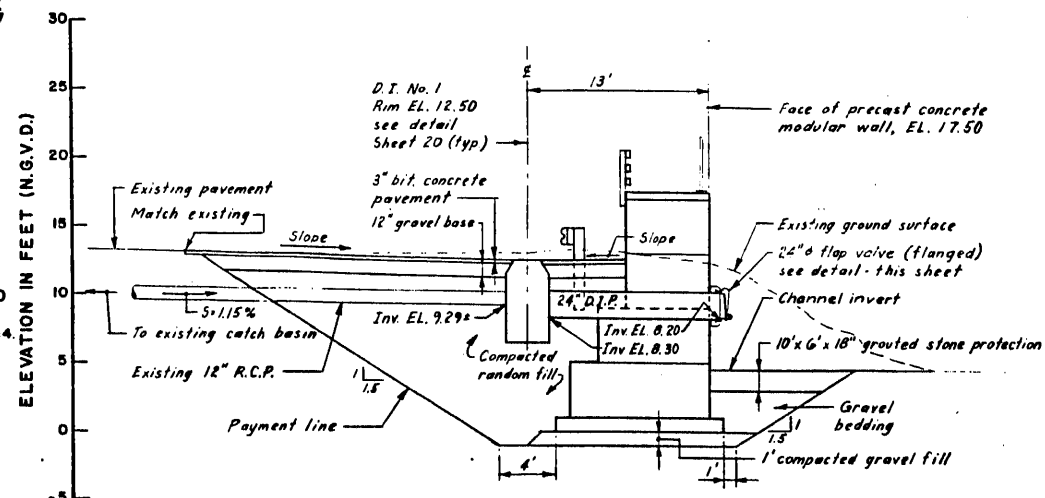
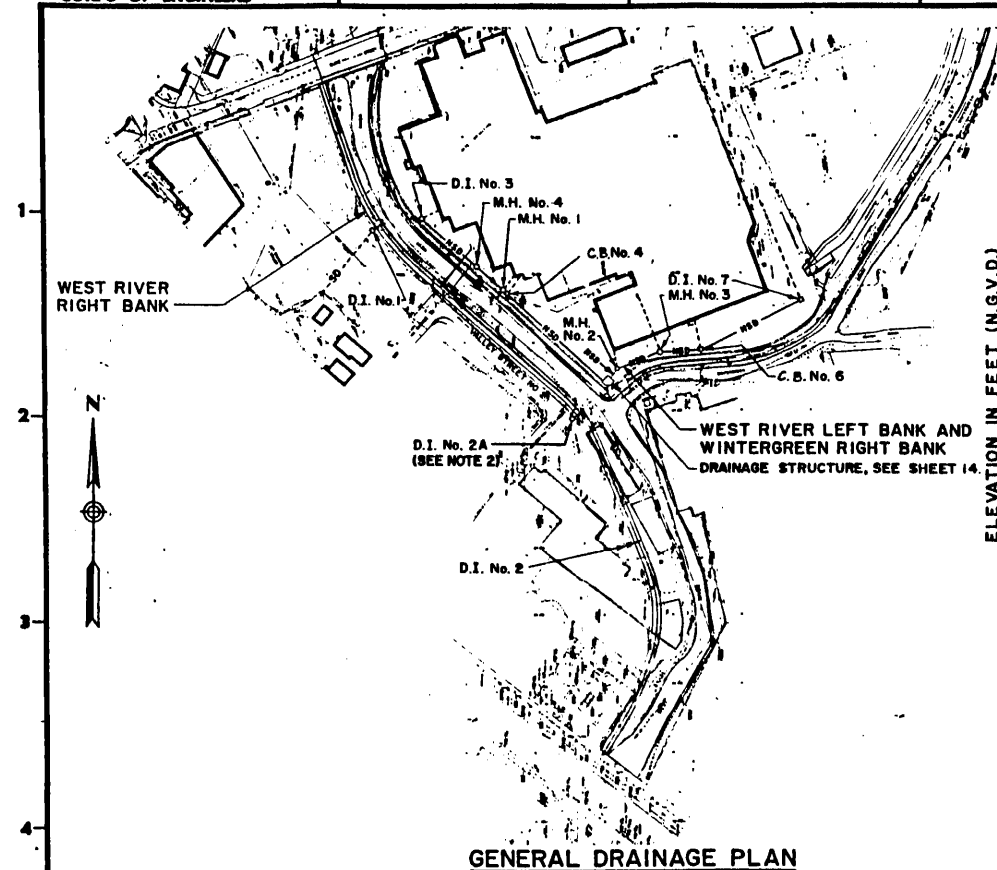
REVISION	DATE	DESCRIPTION	BY
8-30-93	Final field corrections		

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

WATER RESOURCES DEVELOPMENT PROJECT
NEW HAVEN, CONNECTICUT
LOCAL PROTECTION PROJECT
ENLARGED PLANS AND SEWER PROFILE
WEST RIVER & WINTERGREEN BROOK, CONNECTICUT

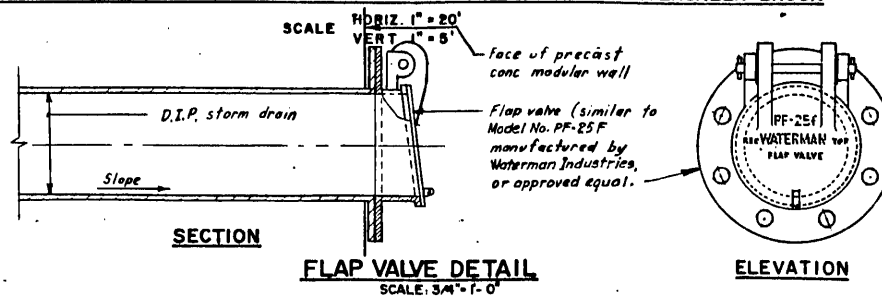
APPROVED: [Signature]
DATE: APRIL 1, 1990
CHIEF, ENGINEERING DIVISION

SCALE: AS SHOWN SPEC. NO. DACW 33-90-B-0098
DRAWING NUMBER
NHW - 1
SHEET 6A



GENERAL UTILITY NOTES:

1. All active drainage pipes shall be connected to the new storm drain system.
2. All intercepted and abandoned storm drains located under the new wall or dike alignment shall be removed as part of the general excavation for this project.
3. All abandoned utility lines shall be plugged, see specifications under site preparation.
4. All drainage manholes shall have grates, see detail on Sheet 20.
5. Actual locations and inverts of all existing utility pipes shall be verified in the field prior to construction.
6. 6" perf. polyethylene underdrain: West River Left Bank, begin at Sta. 11+20 invert EL. 7.10, discharge into drainage structure at invert EL. 5.60. Wintergreen Brook Right Bank, begin at Sta. 19+50 invert EL. 6.62, discharge into drainage structure at invert EL. 5.60. See "Underdrain Detail" on Sheet 9.

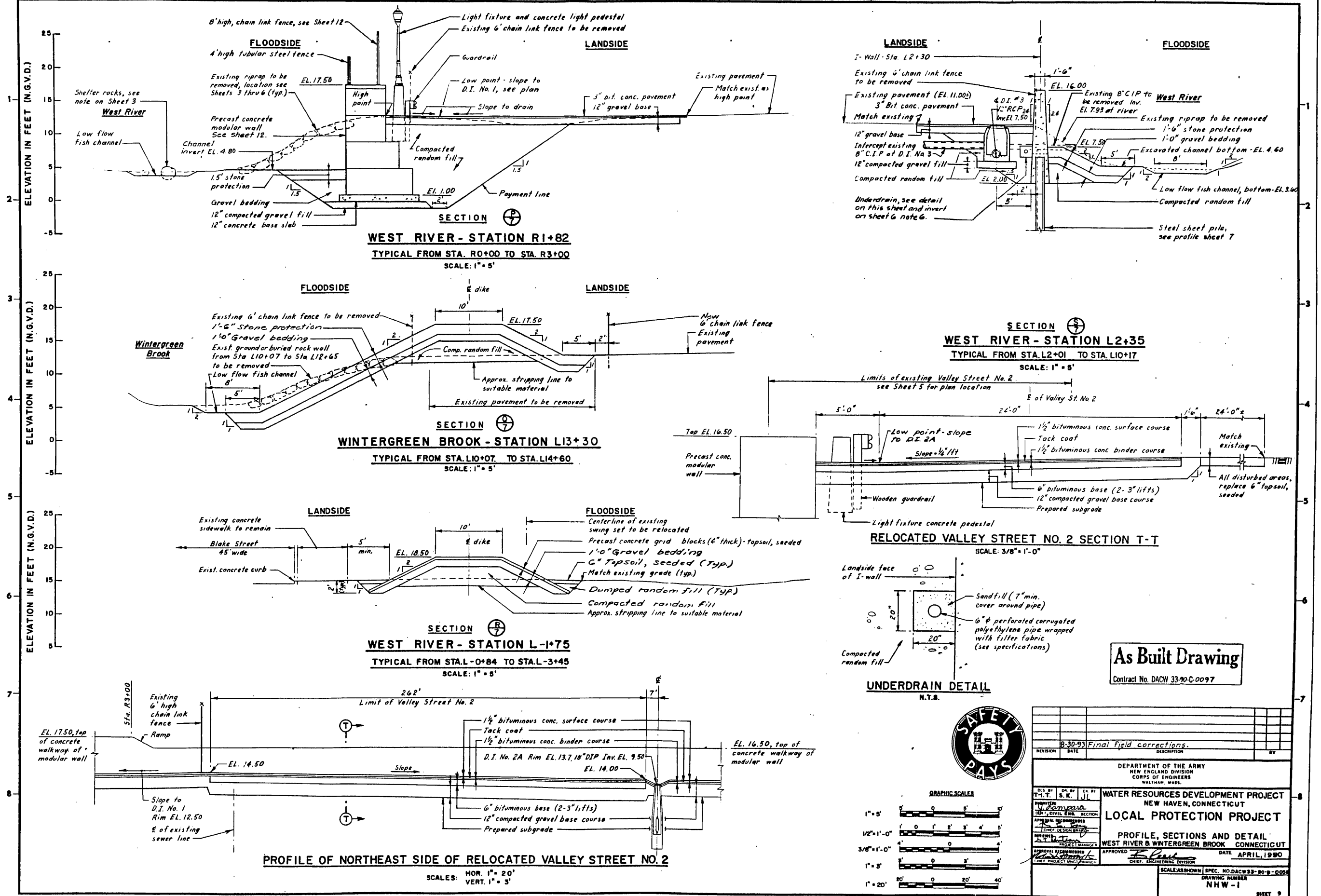


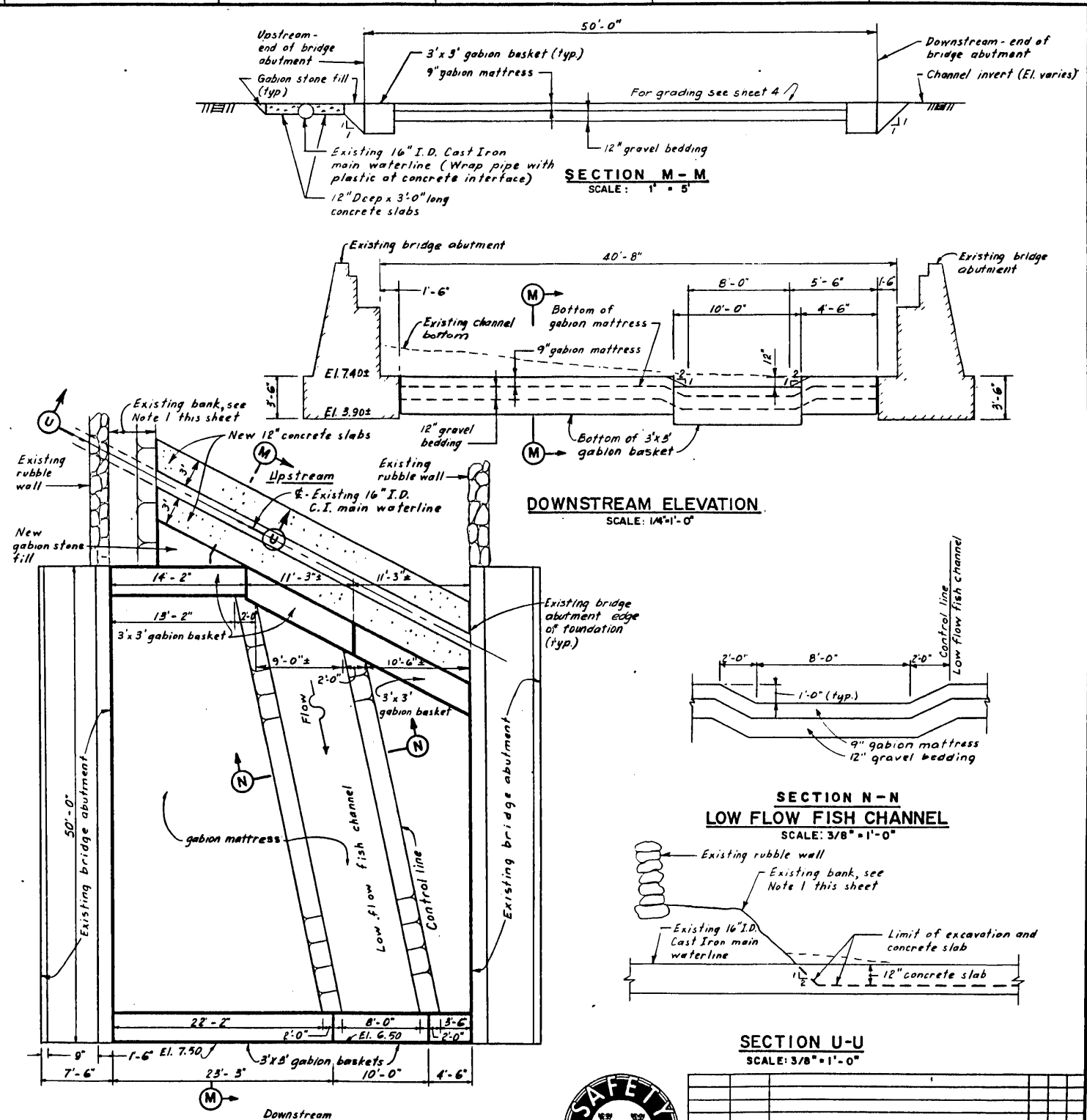
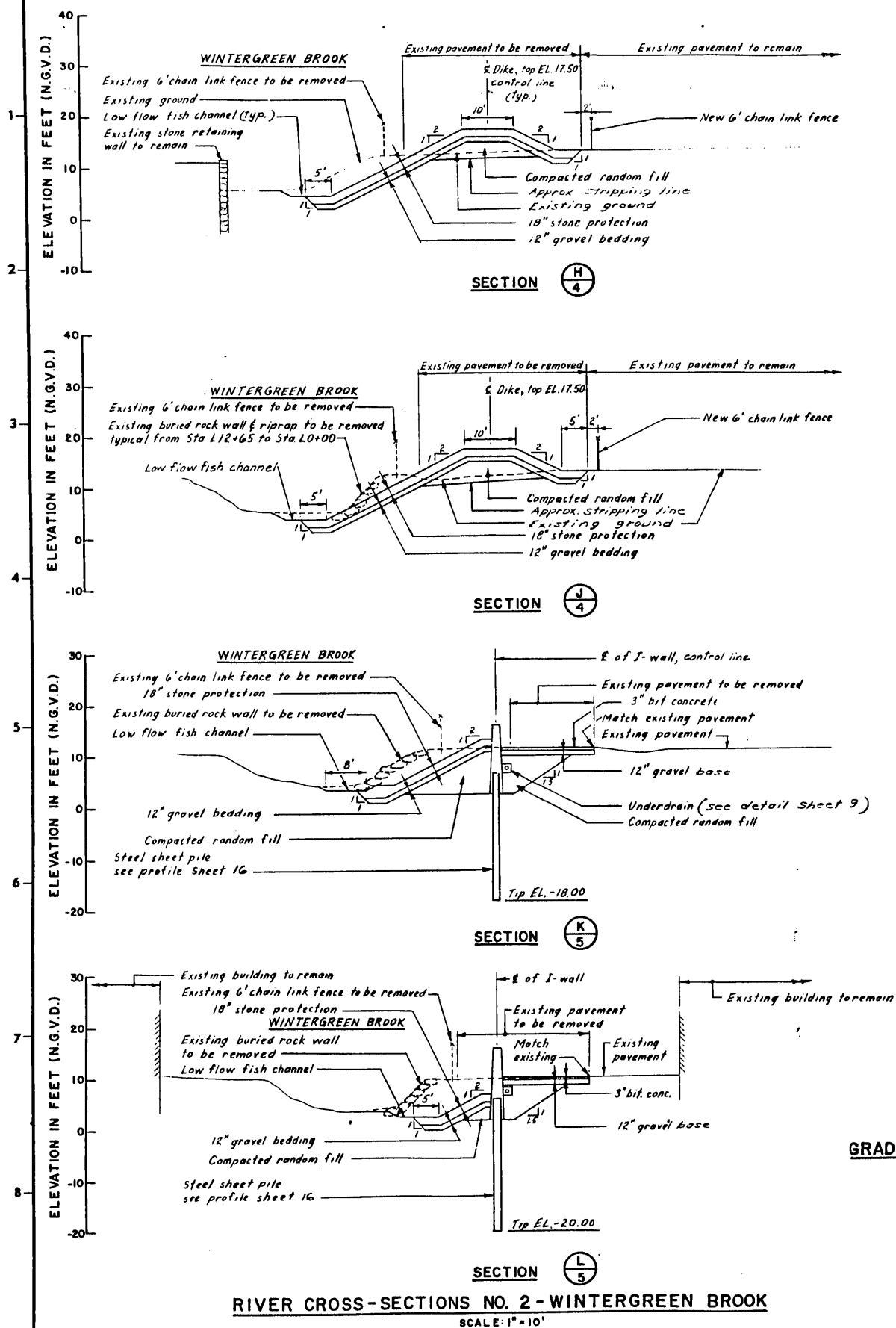
As Built Drawing

Contract No. DACW 33-90-C-0097



8-30-93 Final Field Corrections		REVISION	
DEPARTMENT OF THE ARMY NEW ENGLAND DIVISION CORPS OF ENGINEERS WELLS, B.A.B.			
WATER RESOURCES DEVELOPMENT PROJECT NEW HAVEN, CONNECTICUT			
LOCAL PROTECTION PROJECT GENERAL DRAINAGE PLAN AND PROFILE NOS. 1, 2, AND 3.			
WEST RIVER & WINTERGREEN BROOK, CONNECTICUT			
APPROVED: [Signature]		DATE: APR. 1990	
SCALE: AS SHOWN		SPEC. NO. DACW33-90-B-0058	
DRAWING NUMBER		NH-1	
SHEET 8		PLATE 7	



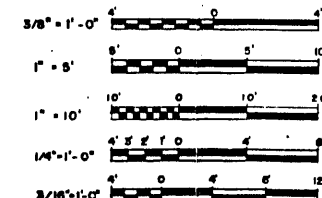


PLAN
GRADE CONTROL STRUCTURE AT WINTERGREEN BROOK
SCALE: 3/16" = 1'-0"

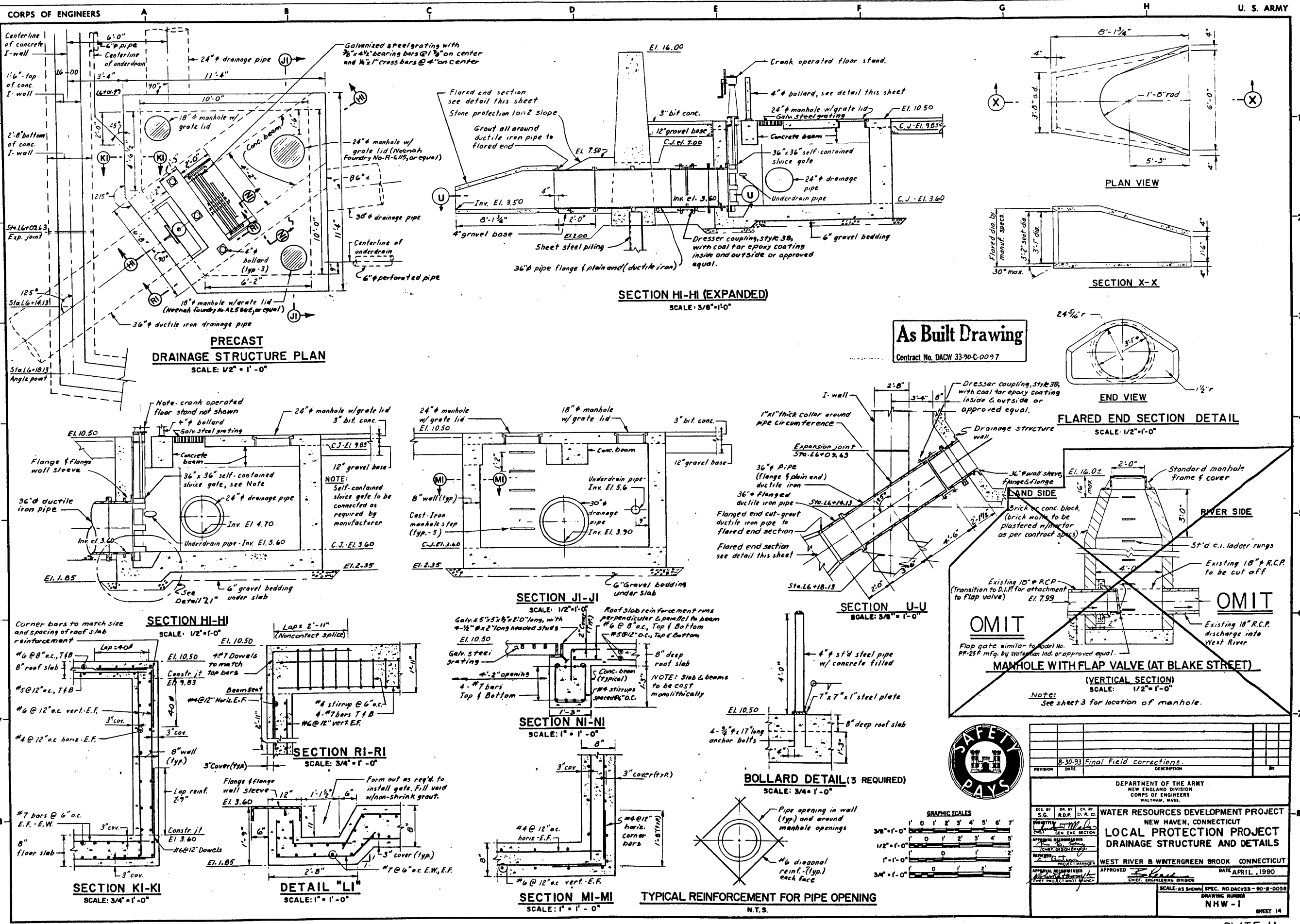
NOTE:
1. The contractor shall not disturb or undercut the existing bank.

As Built Drawing

Contract No. DACW 33-90-C-0097



8-30-99 Final field corrections		DATE	DESCRIPTION	BY
DEPARTMENT OF THE ARMY NEW ENGLAND DIVISION CORPS OF ENGINEERS WASHINGTON, MASS.				
WATER RESOURCES DEVELOPMENT PROJECT NEW HAVEN, CONNECTICUT LOCAL PROTECTION PROJECT RIVER CROSS SECTIONS NO. 2 AND GRADE CONTROL STRUCTURE WEST RIVER & WINTERGREEN BROOK, CONNECTICUT				
DES BY T-I.T.	CHK BY S.K.	DATE	APPROVED [Signature] CHIEF, ENGINEERING DIVISION	
APPROVAL [Signature] PROJECT MANAGER		APPROVED [Signature] CHIEF, ENGINEERING DIVISION		
SCALE: AS SHOWN SPEC. NO. DACW 33-90-9-0058 DRAWING NUMBER NHW-1 SHEET 11				



As Built Drawing
Contract No. DACW 33-90-C-0097



8-30-93 Final Field Corrections			REVISION		DATE	DESCRIPTION
DEPARTMENT OF THE ARMY NEW ENGLAND DIVISION CORPS OF ENGINEERS WATERBURY, MASS.			WATER RESOURCES DEVELOPMENT PROJECT NEW HAVEN, CONNECTICUT LOCAL PROTECTION PROJECT DRAINAGE STRUCTURE AND DETAILS			
DESIGNED BY: S.G. R.D.P. D.K.C.			PROJECT MANAGER: [Signature]			
CHECKED BY: [Signature]			APPROVED: [Signature]			
APPROVED: [Signature]			DATE: APRIL, 1990			
SCALE: AS SHOWN			SPEC. NO. DACW33-90-B-0058			
DRAWING NUMBER			NHV-1			
SHEET 14			PLATE 11			

APPENDIX G
OPERATOR'S GUIDE & REPAIR MANUAL
FOR
CONTINENTAL DIESEL ENGINES
SECTION 7 - PREVENTIVE MAINTENANCE

CONTINENTAL DIESEL ENGINES

OPERATORS GUIDE & REPAIR MANUAL

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 **WIS-CON
TOTAL POWER** CORP.

Section 7 - Preventive Maintenance

In order to obtain maximum efficiency from your diesel engine, a definite maintenance program should be set-up and followed. Haphazard maintenance will only lead to faulty engine performance and shorten engine life.

All moving parts in the engine are subject to wear; however, wear **can be reduced** by careful operation and a planned maintenance program.

In general, diesel engine operation demands careful attention to the cleanliness of **air, fuel and oil** and maintaining coolant operating temperatures of 81°-93°C (180°-200°F.).

The following pages, covering **Daily, 50, 250, 400 and 500** hour maintenance, have been worked out with our field service division as "Minimum Requirements" to keep your engine in dependable operating condition.

DAILY PREVENTIVE MAINTENANCE SCHEDULE

1. OVERALL VISUAL INSPECTION OF ENGINE

Look for evidence of fluid leaks on floor, cylinder head and block, indicating loose fuel, oil or water connections—**tighten if found**.

2. CHECK OIL LEVEL OF ENGINE

The dipstick indicates the high and low oil level in the crankcase—make allowance for additional oil drainage back into oil pan if engine has not been stopped 15 minutes. The most efficient oil level is between the two dipstick levels.

IMPORTANT: Do not add oil until oil level approaches the low mark—then add only enough to bring it to high level—**NEVER** above.

Do not operate the engine with oil below low level mark.



Check Oil Level of Engine

3. CHECK RADIATOR

Fill radiator with a clean 50/50 water/anti-freeze mixture to normal level maintained due to expansion

when heated. Visually inspect fan and belt for condition and adjustment.

4. FILL FUEL TANK

Fill fuel tank at end of day's operation to prevent condensation forming in tank. Clean filler cap and area around spout before filling to prevent entrance of dust into fuel system.

5. CHECK AIR CLEANER

All engines, when operating, consume several thousand cubic feet of air per hour. Since dusty air is full of abrasive matter, the engine will soon **wear excessively** if the air cleaner does not remove the dust before entering the cylinders.

On any air cleaner, operating environment dictates the air cleaner service periods. In extremely dusty operations this may be once or twice daily. In dust protected areas the air cleaner should be serviced when changing oil.

One basic type of air cleaner is normally used—the dry replaceable element type.

DRY TYPE REPLACEABLE AIR FILTER

Dry type air filters are standard equipment on many engines and it is most important that the dirt buildup in the cartridge does not reduce the air flow sufficient to cause a noticeable loss in power.

They should normally be serviced every 50 hours in the following steps: (Extreme conditions will require daily cleaning.)

Remove cover and cartridge after removing wing bolt - do not allow dirt to fall into the exposed carburetor.

Clean cartridge by gently tapping flat on a smooth horizontal surface to loosen and remove the heavier dirt deposits.

CAUTION: Do not damage the gasket sealing surface or bend the outer screen portion of the cartridge while cleaning. Replace the cartridge if in doubt!

The cartridge can also be cleaned with compressed air, but it is important to use the following guidelines:

- **ALWAYS** keep air pressure adjusted to less than 30 psi (2 Bar).

WARNING

Wear protective glasses or a face protector whenever air hoses are used. Never use air pressure that is more than 2 Bar (30 pounds per square inch) and make sure the air line is equipped with a water filter to prevent damage to parts.

Read and observe safety warnings on pages 1 and 2.

- **ALWAYS** keep the tip of the air nozzle or air hose at least 2 inches (50mm) from the paper portion of the cartridge.
- **ALWAYS** blow the cartridge clean from the inside out.

CAUTION: Failure to comply with the above guidelines will damage the cartridge and lead to severe engine damage. Replace the cartridge if in doubt!



Cleaning Dry Type Air Filter

Wipe inside screen, cartridge gasket surface, inside cover and mounting seat before installing element.

Place cartridge on mounting seat - make sure outer edge of cartridge fits inside edge of bottom plate.

Replace cover and assemble wing bolt finger tight to insure air filter seal.

CAUTION: Do not wash or oil cartridge.

Replacing New Cartridge.

Replace immediately if bent, crushed or damaged. Dry type air cleaners are efficient only as long as top and bottom sealing edges are not damaged.

Also surface of air cleaner base and cover where air cleaner cartridge seals, must be clean and not damaged, such as dents or bends.

Often in cleaning the cartridge it is tapped against surfaces that are not flat, thus damaging sealing edges. Regardless of how clean the paper is, if edges are damaged dirt will enter the engine.

The element should be replaced every 250 hours or when servicing does not result in full power recovery - whichever occurs first.

Under extreme dust conditions, more frequent replacement will be required.

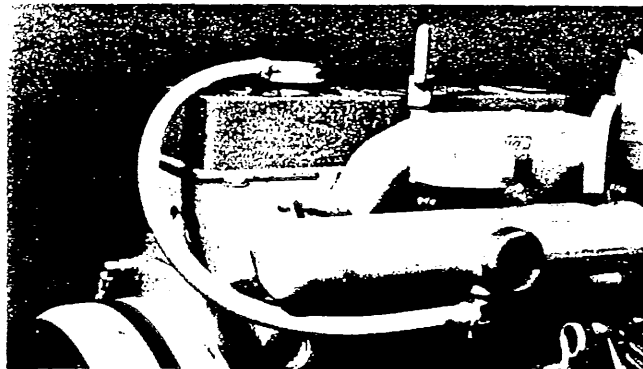
NOTE: A 1/4 teaspoon of dust per hour can ruin an engine in one 8 hour day.

PCV SYSTEM

All connections must be air tight.

Blow-by circulates into the intake manifold maintaining crankcase pressure within a narrow range regardless of operating speed or load.

Servicing of the PCV system is confined to checking the conditions of the hoses and connections.



Typical Teledyne Continental Motors PCV System Installation

CHECK OIL PRESSURE

Note oil pressure gauge which should indicate the following pressure range at full throttle and a minimum of 0.5 Bar (7 pounds) pressure at idling speed.

MODEL	OIL PRESSURE
TMD	2.8 - 4.1 Bar (40 - 60 PSI)

Higher oil pressures may be experienced during cold starts.

NOTE ANY UNUSUAL NOISE

Operators familiar with daily engine operation soon become alert to any noise not normally present. This is very valuable in correcting defects in the early stages and preventing expensive repairs or delays.

EVERY 50 HOURS

1. REPEAT DAILY OPERATIONS OUTLINED

Follow previous Instructions.

2. CHANGE CRANKCASE OIL

Engine life is dependent upon clean oil being circulated to all moving parts; therefore, the frequency of oil changes and oil filter replacement is very important and should be made at regular, scheduled periods.

The schedule for changing oil is directly dependent upon the operational environment: an extremely clean operation could go 100 hours while a dirty operation (foundry or cement factory) could be 50 hours or less.

Replace the oil filter element every time the oil is changed.

Thoroughly clean the sealing surfaces before replacing new element and gasket.

Do not put kerosene into the crankcase. The best method is to drain the oil when the engine is thoroughly heated—which will carry off most of the sediment.

Some operators unwisely put kerosene in the crankcase after draining the engine oil, then turn the engine over with the starter—In the belief they are doing a better job of crankcase cleaning.

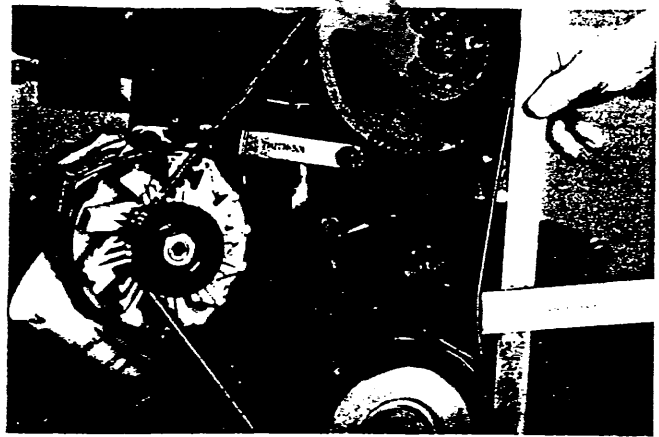
In doing this, kerosene is circulated through the oil pump, the main oil header and the branches leading into the engine bearings—thereby washing away the protective oil film. In addition, some of the kerosene will be trapped and remain to thin out the new oil, reducing its lubricating qualities.

3. SERVICE AIR CLEANER

Clean element with compressed air. (See Daily Instructions.) Be sure that no unfiltered air can enter the engine.

4. CHECK FAN BELT TENSION

Inspect wear condition of fan belt; note alignment and check belt tension which should allow not over 13mm (1/2") deflection on the long span.



Fan Belt Tension

5. CHECK BATTERY

WARNING

Stop engine before checking battery terminals or electrical connections. Sparks or flames near a battery could cause an explosion or fire. Battery acid can cause corrosive burns. Always wear eye protection. Use of jumper cables or battery charging should be done only as directed by manufacturers' safety instructions.

Read and observe safety warnings on pages 1 and 2.

Check specific gravity of each cell—which should be at least 1.250. Add distilled water, if required, to raise level 9.5mm (3/8") above the separators.



Checking Battery

Particular attention should be given the battery during cold weather. The cranking power of a fully charged battery @ 27°C (80°F.) is reduced 60% @ -18°C (0°F.)—but yet the power required to crank the engine is 2 1/2 times greater at -18°C (0°F.) than @ 27°C (80°F.).

6. DRAIN WATER FROM FUEL FILTERS(S)

Note: Some fuel filters are not equipped with a water drain. (See Fuel Filters, page 23.)

7. ADJUST IDLE SPEED TO EQUIPMENT MANUFACTURERS RECOMMENDATION

Repeat again at end of 500 hours.

EVERY 250 HOURS

1. REPEAT DAILY AND 50-HOUR SCHEDULES

Follow previous Instructions.

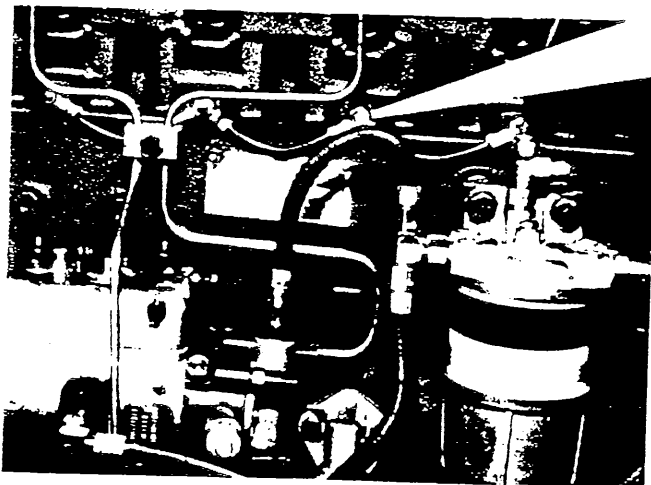
2. CLEAN EXTERIOR OF ENGINE

Use steam if available, otherwise any good commercial engine cleaner to wash down the engine.

CAUTION: Never allow cool water to come in contact with the fuel injection pump while the engine is running! Injection pump seizure may result.

3. CHECK GLOW PLUGS

Inspect glow plug wiring.



Glow Plugs

4. IF DRY REPLACEABLE ELEMENT AIR CLEANER IS USED, REPLACE ELEMENT.

5. FIRST 250 HOURS RECOMMEND ADJUSTING VALVE TAPPET CLEARANCE.

EVERY 400 HOURS

1. REPEAT DAILY AND 50-HOUR SCHEDULES

Follow previous Instructions.

2. FUEL SYSTEM (See fuel filters - page 23)

Replace fuel filter element.

Inspect mounting and gaskets.

Check all connections for leaks.

EVERY 500 HOURS

1. REPEAT DAILY — 50 HOUR AND 250 HOUR SCHEDULES.

2. COOLING SYSTEM

Clean radiator core by blowing out with compressed air.

Inspect radiator mounting.

Inspect water pump and connections for leaks.

Check fan and accessory drive belts.

3. ADJUST VALVE TAPPET CLEARANCE

Check and adjust intake and exhaust valve tappets to following clearances at operating temperature.

MODEL	INTAKE	EXHAUST
TMD	0.36mm (.014")	0.46mm (.018")

4. SAFETY AND THERMAL CONTROLS

Inspect control wires and connections.

APPENDIX H
OWNER'S & OPERATOR'S MANUAL
FOR
PORTABLE PUMPS

OWNER'S AND OPERATOR'S MANUAL

MODELS

4D2 — 4E1A — 4E1P
4E16A — 6E4A — 6E4P
6E6A — 6E6P — 6E8A — 6E8P

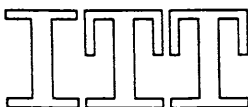
PLEASE FILL IN DATA
FROM YOUR PUMP
NAMEPLATE

Pump model 6E8P

Spec. No. _____

Serial No. 834797

Seal No. _____



MIDLAND PARK, NEW JERSEY 07432 • (201) 444-6900 FAX: 444-3865
CINCINNATI, OHIO 45229 • (513) 482-2500 FAX: 482-2569

**RETAIN MANUAL
FOR REFERENCE**

Thank You

You are now the owner of a Marlow pump.

This pump was carefully inspected
and subjected to final performance tests before shipment.

In order to have maximum performance please follow the simple instructions in this manual.

RECOMMENDED PRECAUTIONS

1. Avoid system pressures that may exceed one and a half times the operating point selected from the pump performance curve.
2. Should the fluid temperature rise more than 50° F. ambient, expansion joints must be installed on both the suction and discharge ports to relieve any stress on the pump casing.
3. No modifications, additions or deletions should be made to the pump, without prior approval of the factory.
4. Prime movers powering the pumps may operate at high temperatures and to avoid burns — keep hands off mufflers & manifolds.
5. In systems where shock wave pressures may be generated, protective devices (check valve/gate valve, etc.) must be installed on discharge line to prevent shock wave pressures from entering casing. A dis-

charge check valve is required when operating against high static heads.

6. Do not re-fill engine fuel tank while power unit is running or while hot. Prevent splashing of gasoline or other fuel while filling supply tank.

7. This pump is designed primarily for water use. Before pumping other liquids, READ CAREFULLY THE CAUTION BELOW.

8. Do not use in a combustible atmosphere.

9. After servicing the unit, always install the coupling guard and/or safety device as originally found prior to disassembly.

10. Drain pump completely before removing cleanout air cover.

11. Make periodic checks of the tightness of suction and discharge pipe, drain, filler plug and pump gaskets. Check tightness of gasoline tank filler cap each time tank is filled. Operation should not proceed until all of the above items have been checked and are tight.

CAUTION:

The performance of ITT Marlow pumps is based upon clear, cold, fresh water with suction conditions as shown on the performance curve. If used to pump other liquids, pump performance may differ from rated performance based on the different specific gravity, temperature, viscosity, etc. of the liquid being pumped. However, a standard pump may not be safe for pumping all types of liquids, such as toxic, volatile or chemical liquids under

extreme temperatures or pressures. Please consult ITT Marlow catalogs as well as local codes and general references to determine the appropriate pumps for your particular application. Since it is impossible for us to anticipate every application of an ITT Marlow pump, if you plan to use the pump for a non-water application, *consult ITT Marlow beforehand* to determine whether such application may be proper or safe under the circumstances. *Failure to do so may result in personal injury, death or property damage.*

WARRANTY

PRODUCT WARRANTY: ITT Corporation (hereinafter "Seller"), warrants for a period of one (1) year from the date of initial operation but not more than eighteen months from the date of shipment ("the warranty period"), that the product manufactured and sold hereunder will be free from defects in material and workmanship. Seller does not warrant product accessories such as engines, motors, gauges, electrical control equipment or other items not manufactured by the Seller. Accessories are subject to warranties as given by their respective manufacturer. Seller's obligation under this warranty is limited to repair or replacement at its' factory or designated location of any part or parts subject to this warranty which Seller's examination shall disclose to its satisfaction to have been defective. Purchaser shall assume all responsibility and expense for removal, reinstallation and freight. Repaired or replaced parts under this warranty will be covered for the Warranty Period only.

EXCLUSIONS FROM WARRANTY: EXCEPT AS PROVIDED ABOVE, SELLER MAKES NO OTHER WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, AND ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED AND EXCLUDED FROM THIS WARRANTY. Seller neither assumes nor authorizes any person to assume for it, any obligation in connection with the sale or repair of the product. This warranty shall not apply to any product or part thereof which (a) has been repaired or altered outside of Seller's factory in any manner; or (b) has been subject to misuse, negligence or accident, or (c) has been used in a manner contrary to Seller's printed instructions.

LIMITATION OF LIABILITY: SELLER'S LIABILITY SHALL NOT EXCEED THE PURCHASE PRICE OF THE PRODUCT, AND IN NO EVENT SHALL SELLER BE LIABLE FOR ANY DIRECT, INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES WHETHER THE CLAIM THEREFORE IS BASED ON TORT (INCLUDING NEGLIGENCE), CONTRACT, WARRANTY (EXCEPT AS SET FORTH ABOVE) OR STRICT LIABILITY.

OPERATING INSTRUCTIONS

MODELS

4D2 — 4E1A — 4E1P — 4E16A —
6E4A — 6E4P — 6E6A — 6E6P — 6E8A — 6E8P

GENERAL

Our shipping container has been specifically designed to prevent transit damage. However, any indications of damage or shortage should be carefully noted on the delivery ticket and a claim filed promptly with the carrier.

PROPER LOCATION IMPORTANT

By placing your pump on a firm, level foundation, you reduce the chance of its falling into the liquid and damaging the engine. You also insure proper oil lubrication of the engine and obtain optimum engine performance. Best pump operation is obtained by locating the pump as close as possible to the liquid being handled, keeping in mind a pump can push liquid more effectively than it can pull or draw liquid.

CONNECTIONS

Connections at the easily accessible suction and discharge ports can be made with either hose or pipe. The use of strongly reinforced suction hose will prevent collapsing of the hose during operation. New hose washers should be used at the couplings to prevent trouble-causing leaks. Pipe joint compound that will not dissolve in the liquid being pumped should be used on all pipe joints. All hose or pipe should be independently supported to eliminate excessive strain on the pump. For best results your hose should discharge higher than the pump to prevent siphoning action when the unit is shut down.

STRAINER

Protect your investment, use a strainer. Strainers are attached to the suction line to prevent stones and foreign debris from clogging the impeller or diffuser, resulting in reduced performance. Stones lodged inside the pump can cause premature wear and poor performance. To keep the strainer from working into the sediment, suspend the hose from the end of a rope. If you do not have a strainer, your ITT Marlow dealer can supply one in the correct size.

STARTING

Follow the engine manufacturer's instructions carefully. Fill the pump tank with liquid before starting.

Your pump has been designed to prime itself in a few minutes with the engine running fast. High suction lifts require additional time and reduce the performance of the pump. Should you have difficulty, refer to the "Trouble Guide" Section.

ITT Marlow pumps prime and reprime providing the tank is filled with liquid. Should you lose this liquid from the tank accidentally or by draining purposely, it will be necessary to refill it with liquid before starting.

LUBRICATION

The latest engineering advancements have been incorporated into our self-lubricating shaft seal. The liquid being pumped cools and lubricates the seal. Running the pump dry will damage the seal. Always keep liquid in the tank for seal lubrication.

The shafts of all liquid-cooled engine driven pumps are supported by a heavy duty bearing in the center of the pump lantern or bracket and by a bushing in the center of the engine flywheel. The bearing supporting the flywheel is a main bearing of the engine. It is lubricated by the engine. The ball bearing in the center of the lantern must be lubricated every 50 hours of operation. Add grease through the fittings provided until grease comes out of the relief fitting (when provided) or along the shaft.

Keep the engine lubricated in accordance with the manufacturer's instructions.

SUCTION PIPING

1. Suction piping should be as short as possible using the fewest number of elbows and fittings to reduce friction loss and avoid possible priming problems.
2. The designer of the piping system must be sure that the available NPSH of the system exceeds the required NPSH of the pump. (Refer to pump performance curve for the value of the NPSH required by the pump at the operating point).
3. Suction piping should be the same size as the pump inlet.
4. Any reducer should be of the eccentric type. If a reducer is used in the horizontal run of suction piping it must be used with *flat* part of reducer on the *top* to avoid air pockets.
5. A horizontal portion of the suction line must have a gradual *rise* to the pump from the source of the liquid being pumped. Any high point in the suction line will create an air pocket, and will prevent proper pump operation and inhibit priming capability.
6. An installation requiring long pipe lines handling hot or chilled liquids, requires provision for relieving the expansion and contraction of the pipe to eliminate any pipe stress from acting on the pump casing.
7. It is recommended to use long radius elbows and eccentric reducers whenever possible. These types of fittings reduce friction loss. Tapered reducers should only be used in *vertical* suction piping.

OPERATING INSTRUCTIONS

8. If a suction strainer is used, it should have a mesh size equal to or less than the solid handling capability of the pump, and open mesh area equivalent to a minimum of eight times the area of the suction pipe size.

9. The size and length of the suction pipe, the number and type of pipe fittings, and the height of the static suction lift will determine the *total dynamic suction lift* of each piping system. This system characteristic should be calculated so that it does not exceed the design capacity of the pump causing reduced flow and/or cavitation.

10. Before tightening the suction pipe connection flange, align it exactly with the pump suction flange. Do not pull a pipe into place by tightening the flange bolts and/or couplings. All pipe lines near the pump must be rigidly supported to avoid strain on the pump, which may cause excessive vibration, decreased bearing life and/or increased shaft deflection and seal wear.

11. Leaks in the suction line can adversely affect both the pump's priming, and performance; especially when the pump is operating at high suction lift. To prevent leaks, make sure all piping connections are tightly sealed. The piping gasket sealant used should be compatible with the liquid being pumped.

12. If a single suction line is installed into a sump, it should be installed away from the sump wall at a minimum distance equal to 1 1/2 times the diameter of the suction line. If more than one suction line is installed in the same sump, separate the suction lines from each other by a minimum distance equal to three times the diameter of the largest suction line.

13. If there is a discharge from an open pipe into the sump, the flow should be kept away from the pump's suction pipe. This inflow usually carries air down into the sump with the liquid. Liquid with entrained air will increase priming time and reduce pump efficiency. If the discharge into the sump is close to the suction pipe, install a baffle between the inflow and suction pipe at a distance of at least six times the diameter of suction pipe away from the suction pipe. The baffle will allow the air to escape from liquid before it is drawn into the suction pipe.

14. Recommended are the use of bell type increasers at the bottom of the suction pipe to reduce inlet velocity. If this can't be done, cut the bottom of the suction pipe at a 45° angle to avoid swirling of liquid.

VALVES

Marlow does not recommend the use of a valve on the suction line **EXCEPT:**

- In case where positive suction heads are present in the system or
- Where it is possible for a positive suction head to develop due to flooding conditions.
- Sometimes it is advisable to have valves on suction and discharge so that the pump may be isolated during repair.

In any case if suction valve is used, install with stems in horizontal position to avoid air pockets.

- If throttling valves are necessary in the discharge line, use a valve size equivalent to the largest pipe size in the line to minimize friction loss. Never install a throttling valve in the suction line.
- Gate and check valves may be used on the discharge side, but it is not necessary in low discharge head applications.
- It is recommended to use a throttling valve and check valve in the discharge line to protect the pump from excessive shock or water hammer and reversed rotation when pump is stopped.

DISCHARGE PIPING

- To minimize piping friction losses:
 - Keep discharge line as straight as possible.
 - Use the minimum number possible of elbows and other pipe fittings.
 - Use *long radius* elbows and/or eccentric reducers.
- Do not terminate the discharge line at a level lower than that of the liquid being pumped, unless a siphon breaker is used in the discharge line. Siphoning action may cause damage to the pump.
- If there is a high discharge head, slow re-priming may be encountered requiring the use of an air venting device. If a discharge check valve is used an air release line must be incorporated between the discharge check valve and pump to insure priming.
- If the system has a long discharge line it is recommended to install a siphon breaker to avoid siphoning out the liquid from pump casing.

MAINTENANCE

- The pump is filled with a mechanical shaft seal which requires no other lubrication than the liquid in which it operates.
- On occasion, the mechanical shaft seal may become worn and must be replaced. Follow the replacement instructions enclosed with each seal assembly.
- When pump is not in use for several days, or for winter storage, drain all the liquid from the tank. Remove the ignition wire from the spark plug before rotating the pump shaft a few turns. Rotating the shaft will help prevent rust formation around the impeller.
- Follow the engine manufacturer's manual for periodic maintenance and adjustment. Also follow their procedure for winterizing the engine as set forth in the manual.
- Maintenance and functional problems relating to the engine should be referred directly to the manufacturer's service station.

OPERATING INSTRUCTIONS

WINTER STORAGE

1. Wash off the exterior of the pump.
2. Flush suction line, discharge line, pump casing and impeller of all solids by pumping clear liquid for a short time, or using an external source of clean water.
3. Drain pump casing, suction line and discharge line.
4. If complete draining is impossible add a small amount of anti-freeze into the pump casing. Rotate shaft for mixing.
5. If the bearings are oil lubricated, drain the old oil from the bearing housing and refill the housing cavity with the proper grade of oil (refer to the lubrication section of the

Owners and Operators Manual).

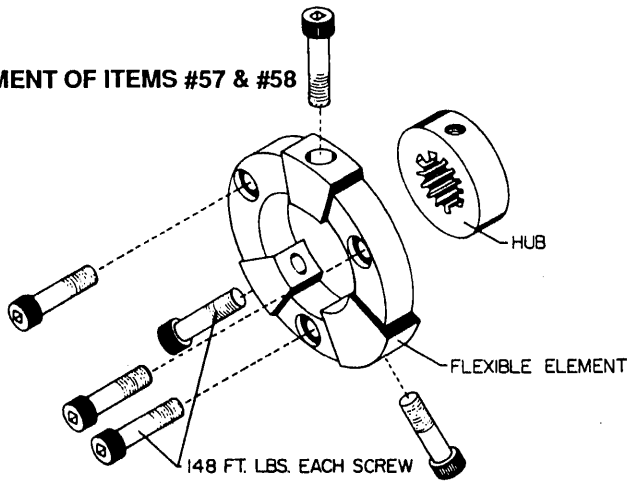
6. If the bearings are grease lubricated, lubricate them.
7. Seal off the suction and discharge ports of the pump casing.
8. Store the units in a dry, clean area if possible.
9. Motor windings should be protected from excessive moisture. Follow the motor manufacturer's instructions.
10. Spray the interior of the pump casing with a commercially available anti-rust and anti-corrosion petroleum aerosol.
11. Rotate the pump shaft once a month during storage period to avoid freeze up and to lubricate bearings.

TROUBLE GUIDE

Note: Before implementing any remedial action recommended in the following Trouble Guide, refer to "Recommended Precautions" and "Warning" sections of this manual. The following are some common causes of problems that may arise:

SYMPTOMS	PROBABLE CAUSE	RECOMMENDED ACTION
Will Not Prime	1. No Liquid 2. Air leak 3. Blocked line 4. Worn seal	1. Fill tank with liquid 2. Tighten all suction line joints, couplings or connections 3. Clean hose & strainer 4. Install new seal
Stops pumping until engine is stopped & restarted	Collapsing suction hose lining	Replace Hose
Suddenly stops pumping	Clogged strainer or hose	Clean hose and strainer
Slowly stops pumping	Clogged impeller, diffuser or lines	Clean out debris and use strainer
Leakage around pump shaft while operating	Worn seal	Replace seal
Will not hold prime	Dislodged or worn check valve	Clean or replace check valve and seat
Performance poor	1. Worn impeller or seal 2. Engine not up to speed 3. Suction lift too high 4. Suction hose too small	1. Replace with new 2. Refer to engine manual 3. Relocate pump closer to supply 4. Use larger size hose

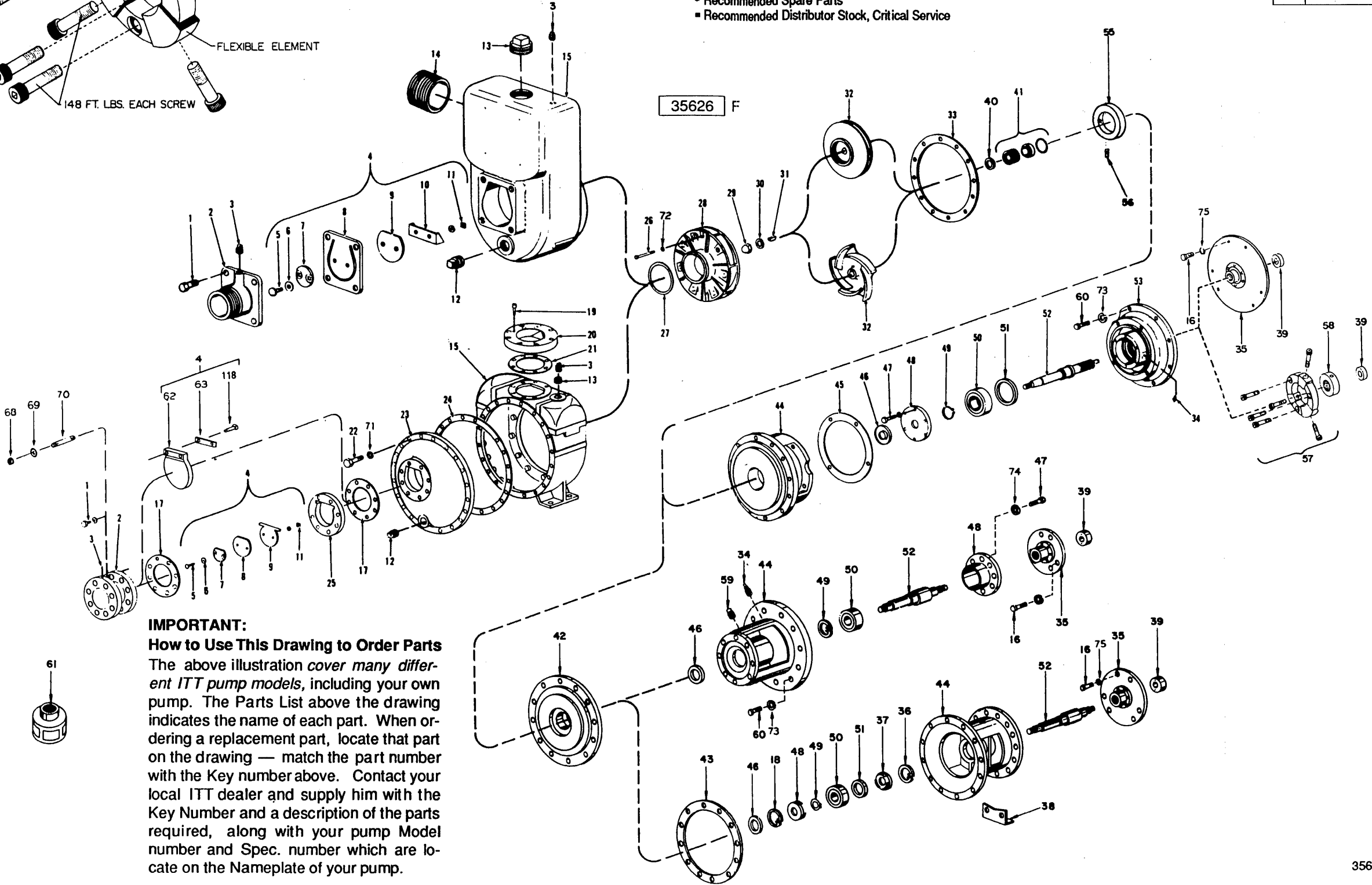
ENLARGEMENT OF ITEMS #57 & #58



PARTS LIST

KEY	DESCRIPTION	KEY	DESCRIPTION	KEY	DESCRIPTION	KEY	DESCRIPTION	KEY	DESCRIPTION
1	Cap Screw	14	XH Nipple	25	Spacer Plate	37	Bearing, Cap	* 49	Retaining Ring
2	Inlet	15	Tank	26	Cap Screw w/ Lockwasher	38	Lantern Support	* 50	Ball Bearing
3	Pipe Plug	16	Cap Screw w/ Lockwasher	* 27	Gasket, Diffuser	* 39	Shaft Pilot	* 51	Bearing Shim
* 4	Check Valve Ass'y	* 17	Gasket, Inlet or Spacer	* 28	Diffuser	* 40	Impeller Shim	52	Shaft
5	Carriage Bolt	18	Retaining Ring	* 29	Impeller Nut	* 41	Seal Assembly	53	Adapter
6	Gasket, Bolt	19	Cap Screw	* 30	Impeller Washer	42	Seal, Plate	54	Cap Screw w/ Lockwasher
7	Lower Weight	20	Discharge Flange	* 31	Impeller Key	43	Gasket, Plate	55	Imp. Laby. Adapter
* 8	Check Valve	* 21	Gasket, Flange	* 32	Impeller	44	Lantern	56	Set Screw
9	Upper Weight	22	Cap Screw	* 33	Gasket, Tank	45	Shim Lantern	57	Flexible Element w/ Screws
10	Stop Plate	23	Cover, Tank	34	Alemite Fitting	* 46	Slinger	58	Hub
11	Hex Nut	* 24	Gasket, Cover	35	Drive Plate	47	Cap Screw w/ Lockwasher	59	Relief Fitting
12	Drain Plug			36	Retaining Ring	* 48	Bearing Cap		
13	Filter Plug								

* Recommended Spare Parts
■ Recommended Distributor Stock, Critical Service



IMPORTANT:
How to Use This Drawing to Order Parts
The above illustration cover many different ITT pump models, including your own pump. The Parts List above the drawing indicates the name of each part. When ordering a replacement part, locate that part on the drawing — match the part number with the Key number above. Contact your local ITT dealer and supply him with the Key Number and a description of the parts required, along with your pump Model number and Spec. number which are locate on the Nameplate of your pump.